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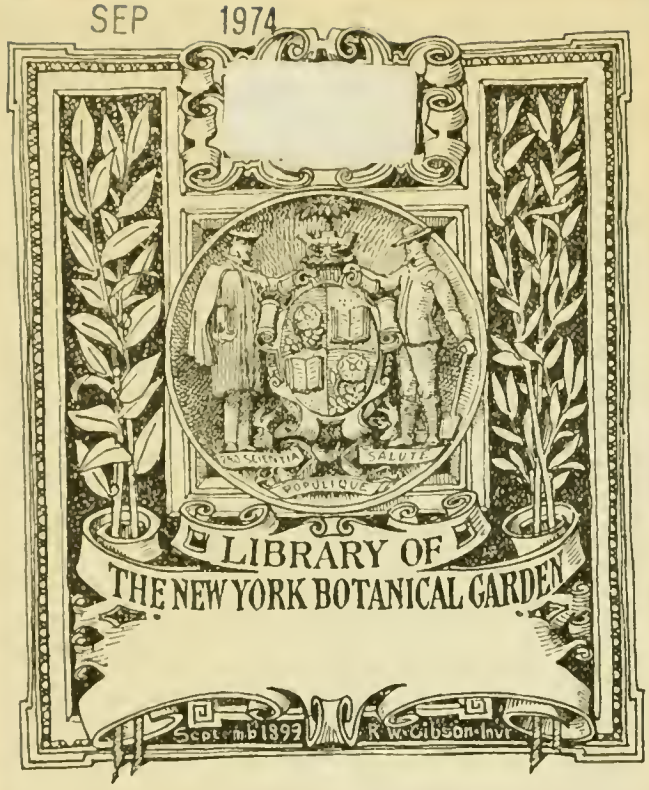
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WHITE PINE FOREST.

BULLETIN No. 22.

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DIVISION OF FORESTRY.

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THE WHITE PINE.

(PINUS STROBUS Linnæus.)

BY

V. M. SPALDING,

Professor of Botany in the University of Michigan.

REVISED AND ENLARGED BY

B. E. FERNOW,

Chief of the Division of Forestry.

WITH CONTRIBUTIONS:

INSECT ENEMIES OF THE WHITE PINE . . By F. H. CHITTENDEN, Division of Entomology.

THE WOOD OF THE WHITE PINE . . . . . By FILIBERT ROTH, Division of Forestry.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1899.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
Washington, D. C., March 15, 1898.

SIR: I have the honor to submit herewith for publication a monograph on the White Pine of the Northern United States.

The first draft of this monograph, like the one on "The Timber Pines of the Southern United States" (Bulletin No. 13, Division of Forestry), by Dr. Charles Mohr, was prepared more than ten years ago by Prof. V. M. Spalding, of Ann Arbor, Mich.; but it was then found that much information of practical value was still lacking, and hence publication was delayed until the deficiencies could be supplied. Professor Spalding, after having made several revisions, under the pressure of other work had to abandon the idea of amplifying and perfecting the monograph itself, and this was left to the undersigned, with the collaboration of the staff of the Division of Forestry.

The undersigned is responsible not only for the plan of the work, but especially for the portions referring to forest conditions, forestal treatment, and for the discussion on the rate of growth, to which Mr. Mlodziansky also contributed.

Mr. Filibert Roth, of the Division, besides furnishing the study on the wood of the species, has also contributed the portions on the history of the lumbering operations, while the discussion on the injurious insects is by Mr. F. H. Chittenden, of the Division of Entomology.

A very comprehensive investigation into the rate of growth of the White Pine has been carried on since 1892 as opportunity afforded and funds permitted. The results of this investigation, comprising the analysis of over seven hundred trees, in the form of tables and notes, will be found in the Appendix. The measurements in the field were mainly executed by Mr. Austin Cary, of Bangor, Me., and by Mr. A. K. Mlodziansky, of the Division. The latter also performed the calculations and tabulations in the Division, and in this work developed a short and satisfactory method of tabulating, analyzing, and using the large mass of data readily for the purpose of summarizing, averaging, and generalization. This method is described in Bulletin No. 20, Division of Forestry.

The situation regarding White-Pine supplies has materially changed since this monograph was first conceived, so that it might almost be charged that this publication comes too late. This would be a misconception both as to the situation and the objects of the monograph. No information of any kind could have arrested the decimation of our White-Pine supplies, which proceeds through the momentum of economic laws; and even now, when it is well known that a few years will see their exhaustion, no change in the methods of milling with a view to lengthening the supplies is contemplated by the manufacturer, who is only concerned in keeping his mill running. The manufacturer is a harvester, not a forest grower.

The object of this monograph is to lay the basis for an intelligent recuperation of the virgin growth by the forest grower of the future, work which will surely be begun presently, but which would not have been undertaken ten years ago.

In the preparation of this monograph use has been made of all available sources of information. Acknowledgments are due to a large number of correspondents, named in the proper connection, who have rendered valuable aid by contributing notes on distribution or have assisted in other ways.

The botanical illustrations showing external characters are by Mr. George B. Sudworth; those of the anatomy of the wood are by Mr. N. B. Pierce and Mr. Filibert Roth, and those of parasitic organisms and disease conditions are from Hartig's "Lehrbuch der Baumkrankheiten" and "Zersetzungserscheinungen des Holzes." The illustrations accompanying the section on injurious insects were furnished by the Division of Entomology. The map of distribution was prepared in the Division of Forestry.

The monograph is believed to be just in time for the use for which it is intended, namely, to prepare for the application of sylviculture to the remnant of our pineries.

Respectfully,

B. E. FERNOW,
Chief of Division.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE WHITE PINE.

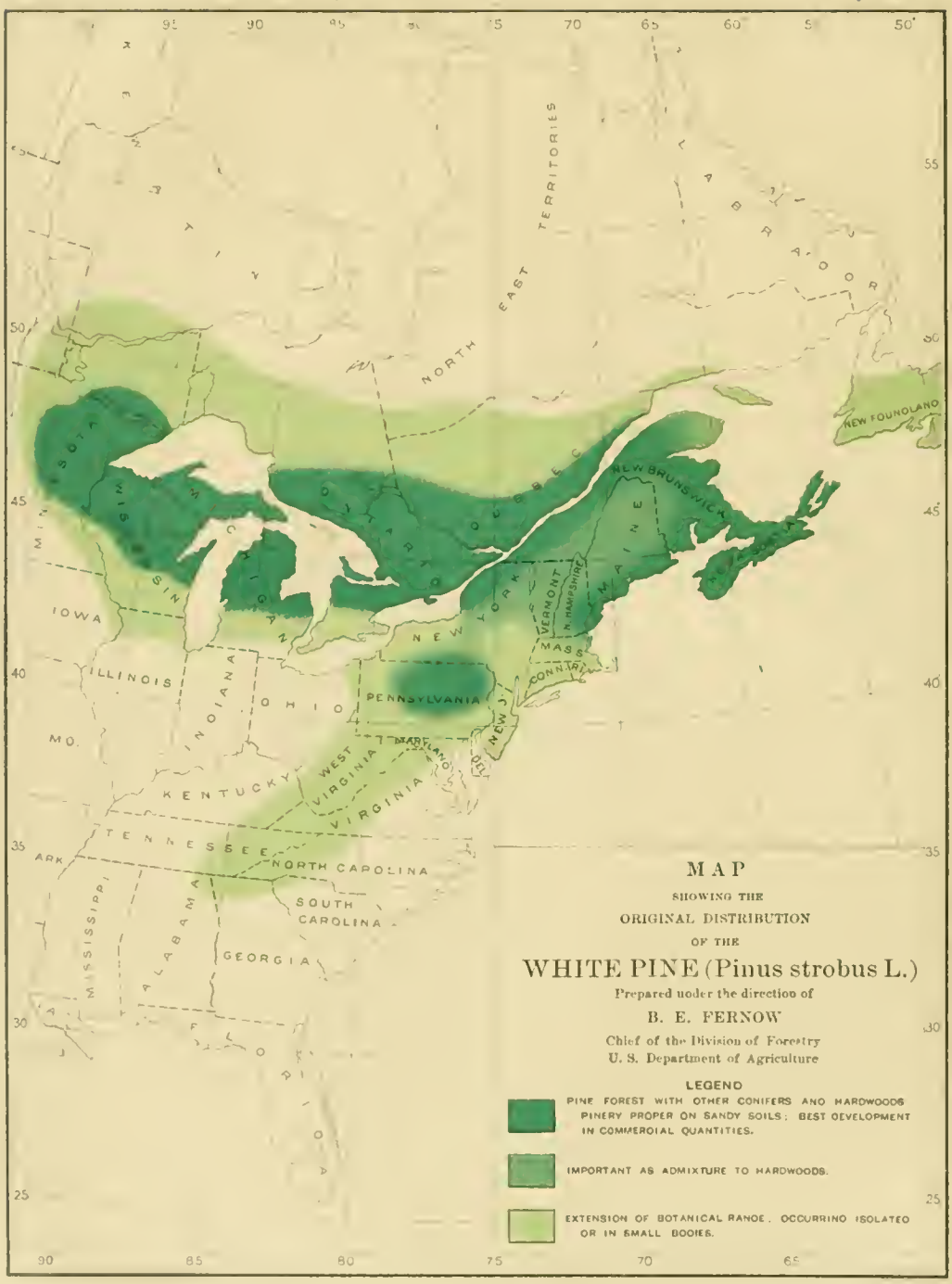
(PINUS STROBUS Linnæus.)

SYNONYMS.

Pinus strobus Linnæus, Spec. Pl. ed. 1, 1001 (1731).
Pinus tenuifolia Salisbury, Prodr. 399 (1796).

LOCAL OR COMMON NAMES.

White Pine (Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Virginia, West Virginia, North Carolina, Georgia, Indiana, Illinois, Wisconsin, Michigan, Minnesota, Ohio, Ontario, Nebraska).
Weymouth Pine (Massachusetts, South Carolina, European literature).
Soft Pine (Pennsylvania).
Northern Pine (South Carolina).
Spruce Pine (Tennessee).



MAP

SHOWING THE

ORIGINAL DISTRIBUTION

OF THE

WHITE PINE (Pinus strobus L.)

Prepared under the direction of

B. E. FERNOW

Chief of the Division of Forestry
U. S. Department of Agriculture

LEGEND

PINE FOREST WITH OTHER CONIFERS AND HARDWOODS PINERY PROPER ON SANDY SOILS; BEST DEVELOPMENT IN COMMERCIAL QUANTITIES.

IMPORTANT AS ADMIXTURE TO HARDWOODS.

EXTENSION OF BOTANICAL RANGE, OCCURRING ISOLATED OR IN SMALL BODIES.

A. Hoen & Co. Lith. Baltimore

THE WHITE PINE.

INTRODUCTION.

For two centuries and a half the White Pine has been universally employed for purposes of construction in the Northern United States. Its abundance and the combination of qualities which adapts it to an almost unlimited number of uses have made it the most important and the most highly prized of all the timber trees of the region to which it is indigenous. In several of the Northern States it has been a more constant source of wealth and has yielded larger returns than any other single product. Thus, for instance, in 1879, a fair year for comparison, the natural products of the State of Michigan were estimated by Governor Jerome as follows:[1]

Agricultural products	$88,500,000
Timber	60,000,000
Copper	8,000,000
Iron	10,000,000
Salt	2,000,000
Fish	1,000,000

According to this estimate the value of the timber products, chiefly White Pine, was at that time, in round numbers, six times that of the iron, seven and one-half times that of the copper, and thirty times that of the salt product of the State, and amounted to about 35 per cent of all the products of the State combined; and if the value of the entire White Pine product of the present year (1898), some 7 billion to 8 billion feet B. M., be taken into consideration, it will exceed in value at first points of production the entire gold and silver output of the country, which is not much less than $100,000,000.

Commercial interests of great magnitude, dependent upon the handling and transportation of the White Pine product, have been built up in Chicago and other northern cities, and the diminution or failure of the supply must inevitably result in the transfer of the capital thus employed to other purposes or to other centers of distribution. In fact, such changes have already been and are now being made with great rapidity, and much of the capital formerly invested in the pine lands and mills of the northern lake region has been transferred to those of the Gulf States and the Pacific coast.

A multitude of industries is dependent upon a continued and large production of pine lumber, and its failure, though perhaps not threatening such a collapse of business interests as alarmists have pictured, will nevertheless involve serious if not disastrous consequences to the communities relying upon its continuance. The maintenance of an adequate future supply, especially in view of the well-known fact that the existing forests of White Pine can last but a few years longer, at most, is therefore a matter of great economical importance and can not receive too prompt attention.

GEOGRAPHICAL DISTRIBUTION.

The White Pine is a tree mainly of northern distribution, although it occurs along the mountain ranges as far south as northern Georgia. It occupies in this distribution the Boreal and Transition life zones, as defined by Dr. C. Hart Merriam.

[1] Michigan and its Resources, Lansing, 1881.

The botanical range of the White Pine may be circumscribed as follows: From Newfoundland and the Atlantic coast north of the Gulf of St. Lawrence its northern limit runs in a wavy line between the forty-ninth and fifty-first degree of latitude, its most northern extension occurring near its western limit, when, skirting the southeastern end of Lake Winnipeg, it turns southward, following more or less closely the ninety-sixth meridian of longitude, and in a southeastern direction the line which demarcates the boundary between forest and prairie to the Cedar River at the Iowa line, and along the Mississippi River, crossing it near Rock River, when, following this river for some time, it takes an easterly course to the head of Lake Michigan, then in a northeasterly direction through Michigan to the shores of Lake St. Clair and across Ontario, skirting the southern shores of Lake Erie in the two most northeasterly counties of Ohio, then turns southward through the eastern counties of that State, and following into West Virginia near the 1,000-foot contour line along the foothills of the Alleghenies through Kentucky and Tennessee, gradually withdrawing to higher elevations (1,200 feet) into northeastern Georgia; the line then returning northward along the eastern slope and crossing upper Delaware, reaches the Atlantic coast in southern New Jersey.

The distribution of commercially valuable timber is, to be sure, very different and much more confined. The northern parts of Minnesota, Wisconsin, and Michigan contained probably the largest amount of White Pine, the broad belt of commercial pine of these States continuing eastward through Ontario, northern New York, and the northern New England States to New Brunswick and Newfoundland, and following the New England coast, while the higher elevations of the New England States showed preponderantly spruce with pine intermixed. The northern counties of western Pennsylvania also contained a large amount of White Pine timber mixed with Hemlock and hardwoods. The character of this distribution is exhibited by general outlines and shadings on the accompanying map (Pl. I). The extreme limits of its sporadic occurrence can not be fixed with absolute precision, and from the nature of the case must remain more or less indefinite. Similarly, the limits of greater or less development can only be approximately stated.

The occurrence of the White Pine was generally as a component of the mixed hardwood forest of the Atlantic, even in the best developed portions of its range, and under such conditions, that is, in mixture with other species, it seems to attain its most perfect development.

The finest specimens of the highly esteemed "Cork Pine" of Michigan grew among hardwoods on a better quality of soils than those which produced less valued grades. On the lighter sands true pinery (pure or nearly pure growth of White Pine) occurs. Here its admixtures are most frequently of Red Pine (*Pinus resinosa*) and in its northern limits of Jack Pine (*Pinus divaricata*), while on the better and cooler situations it accompanies the spruces (*Picea mariana* and *P. canadensis*) with Balsam Fir (*Abies balsamea*) and Hemlock (*Tsuga canadensis*).

CHARACTER OF DISTRIBUTION, BY REGIONS.

The character of the occurrence of the White Pine in the forest within its field of distribution will readily appear from the descriptions in the tables of acre yield in the Appendix.

In *Maine*, the lower altitudes, along the coast and some of the river valleys, contained in their hardwood forests the White Pine in fine development, which gave to that State its cognomen of the "Pine Tree State." Reports of trees 6 to 7 feet and over in diameter and up to 250 feet in height testify to the capacity of the species in this region. The original stand of this pine in the State is practically entirely removed, while the young growth furnishes now again small quantities of logging material. The higher altitudes, with their slate and granite soils, are stocked entirely with the spruce and hardwood forest in which the pine occurs only as a scattering mixture and of inferior development.

This same manner of distribution applies more or less to *New Hampshire* and northern *New York*. In the Adirondacks the pine, now almost entirely removed, fringes with the Spruce and Balsam Fir the many lakes and water courses and keeps to the lower altitudes; mixed in with the Maples, Birches, Beech, and Spruce, it towers 50 to 60 feet above the general level of the woods, with diameters of 30 to 40 inches. Its reproduction under the shade of its competitors, however, is prevented, young pine being rarely seen except on old abandoned openings in the forest. (See Pl. II.)

FIG. 1. WHITE PINE MIXED WITH HARDWOODS IN CENTRAL NEW YORK.

FIG. 2.—OLD WHITE PINE TREE IN MIXED FOREST (YOUNG PINE IN THE FOREGROUND) IN NEW YORK STATE.

In western *New York* the White Pine was once quite abundant as a concomitant of the hardwood forest. Young growth is now creeping into every wood lot, while in *Pennsylvania* the White Pine occurred undoubtedly in the lower eastern counties in commercial quantities as well as in the adjoining counties of *New Jersey*, where it begins to be a tree of the mountains, the higher slopes, ridges, and tops becoming its favorite habitat. It is here largely associated with Hemlock, which often becomes the preponderant tree. Pure pine growth is rare, but the mixed hardwood forest is seldom without an admixture of White Pine to the extent, as a rule, of about 30 per cent numerically, the soils within the range of its occurrence being seemingly everywhere quite favorable to its growth.

Besides the Hemlock, the coniferous species with which it is found associated are Pitch Pine (*Pinus rigida*) and Spruce, while Red Pine (*Pinus resinosa*), the most successful rival of the White Pine in the lake region, is here rarely met, and then only in single individuals. The hardwoods most frequently represented are Maple, Beech, and Birch, more rarely Oak and Chestnut, with Basswood, Cucumber, Hickory, Cherry, etc., interspersed in single individuals.

The best development of the White Pine is usually found along the water courses. Thus, in Pennsylvania, in Luzerne County the White Pine is situated along Bear Creek and its tributaries; in Clinton County the pine is found on both branches of Hyner Run and along Youngwomans Creek; in Clearfield County there were 20,000 acres along Sandy Creek and its tributaries heavily timbered with White Pine, of which about 2,000 acres of primeval timber are left, which would cut about 100 million feet B. M. of White Pine. In Jefferson County a tract of Hemlock and White Pine forest of about 90 square miles, known as the Hay's tract, is traversed by the North Fork and its tributaries. In Forest County the areas heavily covered with pine were situated along Hickory and Tionesta creeks. There is as yet standing over 100 million feet B. M. of White Pine along Hickory Creek and its tributaries.

The heavy cut of pine in Elk County came from Medix Run, Dents Run, and their tributaries. The courses of the streams follow the trend of the ridges, the substrata of which are usually of a porous nature, consisting in most cases of slate or laminated shale, a soil very favorable to pine situated on moderately elevated grounds and slopes along the hollows and gorges, which, on account of the pervious substratum, offer most satisfactory soil-moisture conditions.

From *New Jersey* the White Pine has practically vanished long ago as a factor in lumber production, and almost as a tree of common occurrence.

With the extension of the distribution southward, the White Pine becomes less frequent and of inferior development; the climate forces it to higher and higher altitudes. It occurs in quantity only in islands or in small bodies on the crests and along the slopes of the Alleghenies, both east and west, usually accompanying water courses in broader or narrower belts.

Regarding the manner of occurrence of the White Pine in these southern regions, the remarks of Mr. W. W. Ashe on the distribution in North Carolina (Bulletin No. 6, North Carolina geological survey, 1898) are more or less applicable:

> The woodland in which White Pine is the dominant coniferous tree is not extensive, but lies in isolated, small bodies along the crest and southern and eastern slopes of the Blue Ridge, or on the low hills on the west, * * * extensive forests seldom being found above the higher limit (3,000 feet in Macon and Jackson counties), or perfect individual development attained below the lower (2,800 feet). In a few places on the southern slope of the Blue Ridge * * * the White Pine is associated with Yellow Pines as well as with deciduous trees, but the trees are generally short-boled, and neither so large nor tall as those growing at a higher elevation to the west of this range. Single specimens or small groups of trees are locally dispersed in the broad-leaf forests throughout the mountain counties between the limits of altitude given above.

It appears from these statements that in these latitudes below the 2,000-foot level this pine can hardly be expected to be of commercial or forestal value for the future.

The area of greatest quantitative development is found around the Great Lakes and in the basin of the St. Lawrence and its tributaries, in the very places most perfectly adapted to its ready and economical exploitation and easy shipment to markets, the large number of streams that are capable of carrying logs, the accessibility of natural ports of distribution, and favorable climatic conditions inviting the logger and lumberman. Michigan, Wisconsin, and Minnesota have thus become known as the great lumber region of the United States.

In *Michigan* the distribution of the species is entirely controlled by the character of the soil, all sandy areas being pinery proper, with large areas of pure growth of several square miles in extent containing only White Pine. Occasionally, and especially on the driest and poorest sandy gravels, the Red Pine (*Pinus resinosa*) associates and sometimes predominates, the White Pine not representing more than 10 to 20 per cent of the number of trees. In the northern regions Jack Pine (*Pinus divaricata*) takes the place of the Red Pine.

The typical pine forest on fresh sandy soils consists of White Pine (45 to 55 per cent of the dominant growth) mixed with Red Pine (25 to 45 per cent) with scattering Hemlock (10 to 15 per cent) and occasional Fir and hardwoods. The undergrowth, usually moderately dense, consists mainly of small Hemlock, Fir, and young hardwoods.

On moister sand with loam or clay subsoil Hemlock and hardwoods replace the pines, the Red Pine vanishing entirely and the White Pine occurring only in large isolated individuals. Into wet or swampy places the White Pine also penetrates in single individuals among Arborvitæ, Hackmatack, and Spruce.

As the loam in the composition of the soil increases, the hardwoods increase numerically, the White Pine occurring only in single individuals and groups, and Red Pine and Hemlock only occasionally. Finally, the heavy clay soils toward the southern range of the species give absolute preponderance or exclusive possession to the hardwoods, mainly Sugar Maple, Yellow Birch, and Beech, although occasionally White Pine appears scattered, or even in smaller or larger groups.

Lumbering of White Pine in Michigan began about 1835, and was at its best in 1883, but now the virgin pine is nearly cut out. Reproduction is satisfactory on the sandy areas wherever fires are kept out, which is rare: on the clay-loam areas reproduction under the shade of the hardwoods is practically impossible.

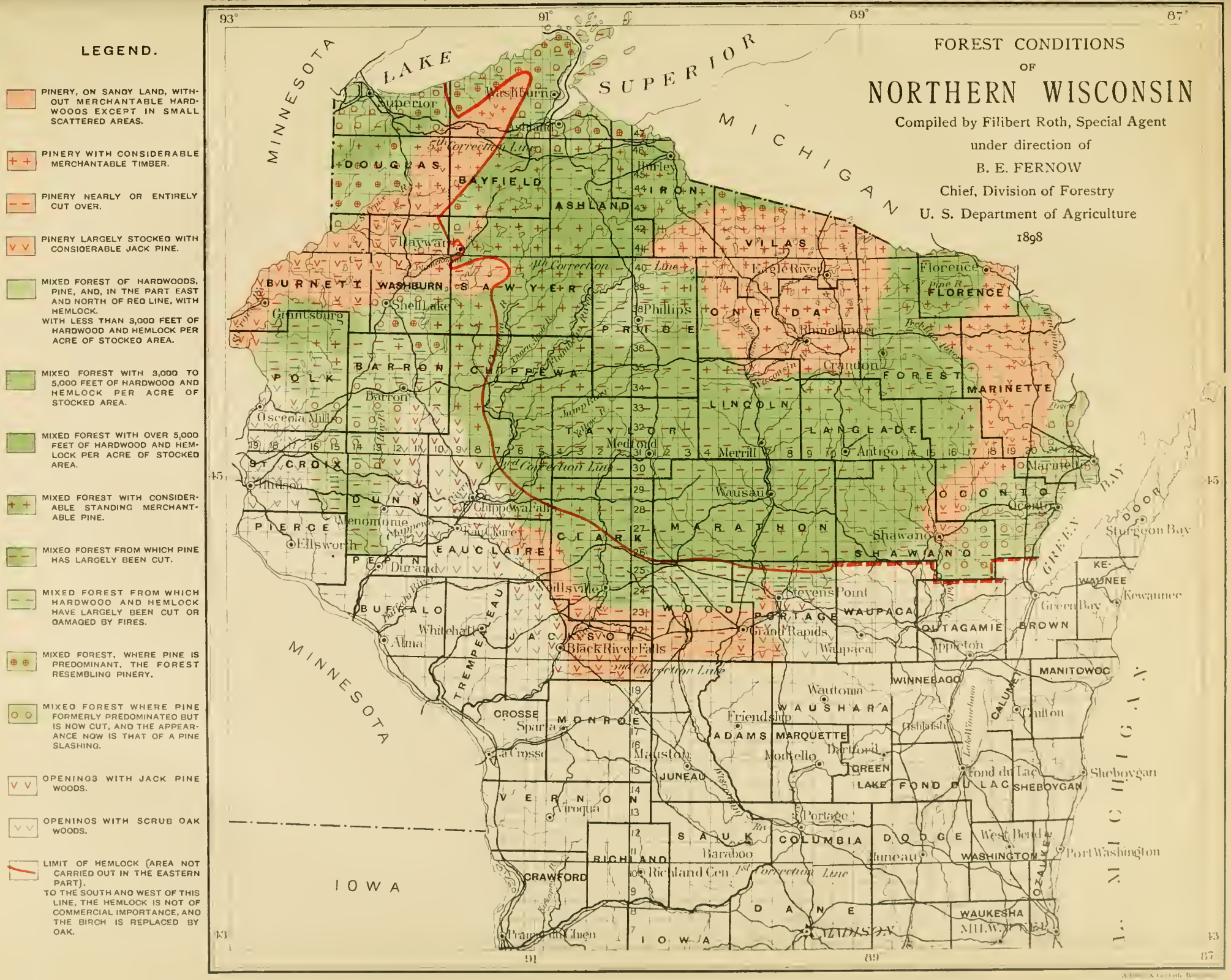
In *Wisconsin* the same dependence on soil conditions in the distribution of the species prevails as in Michigan. The accompanying map of the forest areas of Wisconsin, taken from Bulletin No. 16, of the Division of Forestry, will serve to give an idea of the manner in which this distribution appears within the belt of best development. (See Pl. III.) From this map it will be seen that the distribution is to the largest extent dependent on soil conditions, the sandy soils representing the pinery areas, in which merchantable hardwoods and Hemlocks are wanting; the loam and clay areas are stocked with the hardwood forest, in which both Hemlock and Pine occur scattering or in isolated groves, represented almost entirely by mature old timber. Saplings, bushy young trees, and seedlings are comparatively scarce, an active reproduction of the pine evidently not going on. This condition is found especially on the heaviest soils, where the hardwoods crowd out the pine, while on the sandy or gravelly soils the pine holds its own and forms a fair proportion of the sapling timber. In the true pinery of the sandy soils the hardwoods are scantily represented by small White Birch, Aspen, and Maple. The Hemlock is entirely wanting. On the barrens proper the White Pine is replaced by Jack Pine and Red Pine, one, or both together, forming forests of considerable extent, usually with hardly any undergrowth or admixture save some scattering Scrub Oak.

In *Minnesota* climatic conditions again begin to assert themselves in influencing the distribution of the White Pine.

The conifers become preponderant over the hardwoods everywhere. Pines, both Red and White, together with Tamarack (*Larix laricina*) and Arborvitæ (Cedar—*Thuja occidentalis*) and some admixture of Spruce occupy those sites, both swamp and dry lands, which elsewhere would be occupied by hardwoods. With this change in composition goes a decrease in development; the sizes both in diameter and height are reduced.

It is an interesting fact that both in Wisconsin and Minnesota the pine area does not, as in the eastern field of distribution, gradually fade out toward the prairie, but the true pine woods cease abruptly within 30 or 40 miles at most from the demarcation line of the prairie, leaving the intervening ground to Birch and Aspen or Scrubby Oak and Jack Pine openings.

In the Canadian extension of the species pure pinery is very rare. The great bulk of the most productive pine country lies northward and westward from the mouth of the Ottawa River to Georgian Bay in mixed growth, which consists mainly of hardwoods, with Hemlock, Spruce, Arborvitæ (Cedar), and Balsam, while the lower tiers of Ontario are of the same character of hardwoods, with little scattering pine, as in southern Michigan. The eastern extension of the


FOREST CONDITIONS
OF
NORTHERN WISCONSIN
Compiled by Filibert Roth, Special Agent
under direction of
B. E. FERNOW
Chief, Division of Forestry
U. S. Department of Agriculture
1898
LEGEND.
PINERY, ON SANDY LAND, WITHOUT MERCHANTABLE HARDWOODS EXCEPT IN SMALL SCATTERED AREAS.
PINERY WITH CONSIDERABLE MERCHANTABLE TIMBER.
PINERY NEARLY OR ENTIRELY CUT OVER.
PINERY LARGELY STOCKED WITH CONSIDERABLE JACK PINE.
MIXED FOREST OF HARDWOODS, PINE, AND, IN THE PART EAST AND NORTH OF RED LINE, WITH HEMLOCK.
WITH LESS THAN 3,000 FEET OF HARDWOOD AND HEMLOCK PER ACRE OF STOCKED AREA.
MIXED FOREST WITH 3,000 TO 5,000 FEET OF HARDWOOD AND HEMLOCK PER ACRE OF STOCKED AREA.
MIXED FOREST WITH OVER 5,000 FEET OF HARDWOOD AND HEMLOCK PER ACRE OF STOCKED AREA.
MIXED FOREST WITH CONSIDERABLE STANDING MERCHANTABLE PINE.
MIXED FOREST FROM WHICH PINE HAS LARGELY BEEN CUT.
MIXED FOREST FROM WHICH HARDWOOD AND HEMLOCK HAVE LARGELY BEEN CUT OR DAMAGED BY FIRES.
MIXED FOREST, WHERE PINE IS PREDOMINANT, THE FOREST RESEMBLING PINERY.
MIXED FOREST WHERE PINE FORMERLY PREDOMINATED BUT IS NOW CUT, AND THE APPEARANCE NOW IS THAT OF A PINE SLASHING.
OPENINGS WITH JACK PINE WOODS.
OPENINGS WITH SCRUB OAK WOODS.
LIMIT OF HEMLOCK (AREA NOT CARRIED OUT IN THE EASTERN PART).
TO THE SOUTH AND WEST OF THIS LINE, THE HEMLOCK IS NOT OF COMMERCIAL IMPORTANCE, AND THE BIRCH IS REPLACED BY OAK.
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
GREEN BAY
DOOR
DOUGLAS
BAYFIELD
ASHLAND
IRON
VILAS
BURNETT
WASHBURN
SAWYER
PRICE
ONEIDA
FLORENCE
POLK
BARRON
CHIPPEWA
FOREST
MARINETTE
LINCOLN
LANGLADE
TAYLOR
ST CROIX
DUNN
OCONTO
PIERCE
EAUCLAIRE
CLARK
MARATHON
SHAWANO
PEPIN
BUFFALO
TREMPEALEAU
JACKSON
WOOD
PORTAGE
WAUPACA
OUTAGAMIE
BROWN
KEWAUNEE
MANITOWOC
CROSSE
MONROE
ADAMS
WAUSHARA
WINNEBAGO
CALUMET
MARQUETTE
GREEN LAKE
FOND DU LAC
SHEBOYGAN
JUNEAU
VERNON
SAUK
COLUMBIA
DODGE
WASHINGTON
OZAUKEE
RICHLAND
CRAWFORD
DANE
WAUKESHA
IOWA
Superior
Washburn
Ashland
Hurley
Hayward
Eagle River
Florence
Grantsburg
Shell Lake
Phillips
Rhinelander
Crandon
Barron
Osceola Mills
Medford
Merrill
Antigo
Marinette
Hudson
Wausau
Oconto
Menomonie
Chippewa Falls
Kau Claire
Shawano
Sturgeon Bay
Ellsworth
Durand
Neillsville
Stevens Point
Kewaunee
Green Bay
Whitehall
Grand Rapids
Waupaca
Appleton
Alma
Black River Falls
Wautoma
Friendship
Oshkosh
Chilton
Sparta
La Crosse
Mauston
Montello
Dartford
Fond du Lac
Sheboygan
Viroqua
Portage
West Bend
Baraboo
Juneau
Port Washington
Richland Cen
Prairie du Chien
Madison
Milwaukee
5th Correction Line
4th Correction Line
3rd Correction Line
2nd Correction Line
1st Correction Line
93°
91°
89°
87°
45
43

field of commercial pine in Canada followed mainly the St. Lawrence River as far as Quebec. On Newfoundland the species is indigenous to nearly the whole of the island, and in some parts produces considerable quantities of merchantable timber. At its northwestern limit the forest fades out into prairie, the White Pine gradually disappearing, while at the northern limit the change is into Spruce forest.

NOTES ON GENERAL DISTRIBUTION.

Dr. N. L. Britton, for some years connected with the geological survey of New Jersey, writes of the occurrence of White Pine in that State as follows:

Pine Brook Station and sparingly northward along the Southern Railroad of New Jersey (Britton); sparingly 3 miles south of Woodbury, Gloucester County (Canby), and frequent in the middle and northern portions of the State. There are no White Pine forests in New Jersey, and the largest grove known to me is of but a few acres in extent. It evidently prefers a heavier soil than does *P. rigida*, which forms the forests of the pine barrens. On Staten Island, New York, there are a few scattered trees of *P. strobus*.

Mr. William M. Canby, of Wilmington, Del., reports the existence of a grove of White Pine trees in upper Delaware, and Mr. Thomas Meehan, of Germantown, Pa., states that White Pine grows (or did recently) at the Soapstone quarry, on the east side of the Schuylkill, some 8 or 10 miles above Philadelphia. Mr. Canby adds: "It is a very difficult thing to define the limit of a species that is being so rapidly destroyed, and doubtless the southern line is being rapidly effaced."

Prof. Lester F. Ward, of Washington, D. C., is of the opinion that *Pinus strobus* is not indigenous around Washington, and that the few trees met with in wild situations in its vicinity grew from seeds blown from planted trees. He has never met it in his botanical excursions into southeastern Maryland and Virginia.

Mr. F. E. Boynton writes from Highlands, N. C.:

I have seen some very fine specimens growing in Pickens and Oconee counties, S. C., but I have never seen it in this part of the country except in high altitudes, say from 2,500 to 3,000 feet usually. I have never seen or heard of its forming forests here. I have seen groves of a few acres where it might be said to predominate. As a rule, it is found scattered among other forest trees. It nearly always grows in or quite near Rhododendron and Mountain Laurel thickets, which indicate a moist soil. It often grows to be a very large tree here. I measured a log in the mill yard near here last night that was 37 inches through. Considerable lumber is cut from White Pine in this mountain region, but, as a rule, the lumber is of inferior quality, being very knotty and often shaky. Cultivated specimens thrive and grow very fast. It is usually found most common on southern exposures. The rock formation is granite, and soil usually a sandy or gravelly loam wherever I have observed the White Pine in this region.

The following has been furnished by Prof. W. R. Lazenby, of the State agricultural experiment station at Columbus, Ohio:

From all the data in my possession, I should say that White Pine is rarely met with in Ohio outside the borders of two of our northeastern counties, viz, Ashtabula and Lake. Occasionally a sporadic patch has been noted along the banks of streams in some of the eastern counties. I have never heard of its spontaneous occurrence anywhere throughout the central or southern portions of the State. It appears to thrive well here at Columbus and submits kindly to change of soil. Wherever I have seen it in Ohio under artificial cultivation it has presented a thrifty appearance, although the young plants do not make a very rapid growth for the first few years.

Concerning the occurrence of White Pine near the head of Lake Michigan, Prof. E. J. Hill, of Normal Park, Ill., writes:

It begins at Whiting Station, on the Michigan Southern Railroad, and extends eastward to Michigan City. I came across a clump of White Pine once, about a mile north of Otis, where the Michigan Southern Railroad crosses the New Albany road. * * * You would be pretty safe in taking the Calumet River as the southern boundary. * * * I do not know of a single native tree in Cook County, Ill.

Mr. M. S. Bebb, of Rockford, Ill., communicates the following concerning the occurrence of White Pine in the northern portion of that State:

In a few localities on Kents Creek and Rays Creek, in Winnebago County, and giving the name to Pine Creek in Ogle, the county immediately north of this, the White Pine is certainly indigenous, but occurring only as a sparse growth, cresting precipitous banks, where it seems to have found a favorable environment.

To this Mr. S. B. Wadsworth, of Oregon, Ill., adds:

The White Pine in Ogle County grows in some cases to a height of 40 or 50 feet. * * * Nearly all the small streams in Pine Rock township have some pines near the mouths of the streams if there are any rocks along the banks. * * * The White Pine prefers the St. Peters sandstone, but in some cases grows on limestone rocks.

Mr. R. Williams, of Streator, Ill., says:

White Pine is without doubt a native of La Salle County. It occurs on the Vermilion and its little tributaries wherever there is an exposure of carboniferous sandstone, and more frequently is seen close to the edge of the highest bluffs, where the soil is largely composed of the disintegrated rock. To find one beyond the influence of the sand rock would be almost phenomenal. The number is very small and their situation does not permit them to attain much size. I think that 40 feet is about the limit of height. Small thrifty plants from one to a few feet in height occur here and there, and are sometimes transplanted to the prairie soil, where they make a vigorous growth, outstripping Norway Spruce, Scotch and Austrian Pine, Hemlock, and White Cedar. Pines planted here in 1851 or 1855 are now (1886) about 40 feet high.

The limiting line of the White Pine beyond the Mississippi northwestward is traced substantially as indicated by Mr. Warren Upham in the Geological and Natural History Survey of Minnesota. Mr. Upham sends the following:

The White Pine, wherever I have seen it in New Hampshire and other parts of New England and in the Northwest, prefers somewhat clayey land. It does not thrive on wholly sandy plains ("modified drift" of glacialists),

which are denominated "pine barrens," the congenial dwelling place in the East for the Pitch Pine (*P. rigida*), and in the Northwest for the Banksian or Jack Pine (*P. divaricata*); nor does the White Pine in either region grow plentifully and of largest size on very clayey land, which is the favorite location for Maples, Basswood, Elms, and other deciduous trees. The White Pine in this matter of its choice of soil follows the injunction, *Medio tutissimus ibis*. The Red Pine (*P. resinosa*), so far as I have observed, can thrive better on the very sandy plains and "barrens" than the White Pine, being intermediate in this between the White Pine and the Pitch and Jack pines.

Prof. T. H. Macbride, of the State University of Iowa, says:

I have collected White Pine in the following counties in this State: Mitchell, Howard, Winneshiek, Allamakee, Clayton, Dubuque, Delaware, Jackson, and Muscatine. It is, by others, reported from Scott. It ought to be found also in Fayette, but I have never run across it there.

[This would confine the White Pine in Iowa to the counties bordering the Mississippi River and the Minnesota State line as far west as the Cedar River Valley.]

CONCLUSIONS REGARDING NATURAL DISTRIBUTION.

The leading conclusions to be drawn from what has been stated regarding the natural distribution of White Pine seem to be the following:

(1) Leaving out of consideration all the outlying portions of the region under discussion, there is left an area of not less than 400,000 square miles in the United States and Dominion of Canada within which the White Pine is in its home and surrounded by the conditions of its own choice, throughout which its successful cultivation is fully assured.

(2) A much larger territory than this is included within the limits of extreme distribution as defined above, and there is abundant evidence to show that over nearly the whole of this wide area, and in some directions far beyond it, this species makes under cultivation a healthy and rapid growth. There is apparently no species of equal value indigenous to eastern North America that is at the same time adapted to so wide an area.

(3) The habits of this species near the western limit of its natural occurrence, as well as experimental planting, indicate plainly that its successful growth can not be depended upon much beyond this limit.

THE WHITE PINE LUMBER INDUSTRY.

No species of American timber has been so much used for lumber as the White Pine, and the development of the lumber industry in this country is coincident with the exploitation of the White Pine forests.

The commercial use of White Pine began with the first settlement of New England. The first sawmills were established in the seventeenth century, and numerous small sawmills, which were usually an attachment of the neighborhood gristmill, were in operation early in the eighteenth century. Timber was exchanged for merchandise, and the collections thus made were floated to ports of shipment, whence they were exported. This primitive industry, confined largely to White Pine, was continued well into the third decade of the present century. In 1850, J. S. Springer, of Maine, wrote: "Thirty years ago it was unnecessary to search for a locality for a lumber camp on the Penobscot, for a man could step from his house to his day's work, the pine, that forest king, abounding on every side. Fifty years hence the vast pine forests through which the Penobscot flows will be on the eve of destruction." This prophecy has long since been verified, for the Spruce has practically taken the place of the White Pine in the lumber output of Maine.

This early trade in White Pine, though involving small capital and limited operations on the part of each dealer, was by no means unimportant in the aggregate, lumber being a leading industry in New England from the first. The Bangor Weekly Register of March 2, 1816, noted that between 300 and 400 sleigh loads of lumber, etc., came into Belfast in one day. The Gazette of July 10, 1822, says that 136,086 feet of lumber and 35,000 shingles were hauled in on one Saturday by teams. In 1825 twenty-five vessels were engaged in the lumber trade from Bangor to the West Indies. The mills of those days were all small affairs, generally single-sash saws, driven by water power, with a capacity of 1,000 to 3,000 feet per day. About 1830 the construction of larger mills began, and in 1890 a capital of nearly $12,000,000 was invested in the sawmilling industry in the State of Maine alone.

In general, it may be said that the White Pine of New England was cut by numerous small concerns, and that the bulk of the supplies was cut before modern sawmilling began.

Although the great forests of White Pine in Maine have disappeared, a small amount of this material is still cut in the State every year, so that since 1881, on the Penobscot, for instance, out of a total cut of about 150 million feet per year between 24 and 30 million feet have been pine, the pine thus generally forming 15 to 20 per cent of the entire output.

In Pennsylvania the exploitation of White Pine likewise began quite early. Pittsburg furnished pine lumber to points along the Ohio and even to St. Louis, Mo. As late as 1850 Philadelphia received its 150 million feet of lumber, largely White Pine, from the State, importing but very little from New England and the South. At Williamsport, the center of White Pine lumbering in Pennsylvania, the first large mills were erected about 1838, and the bulk of the pine was cut prior to 1870.

In the forties the White Pine product marketed at Williamsport excelled in quantity all other points of production. The highest production was reached in 1873, with nearly 300 million feet B. M. in logs boomed, which in 1893 had sunk to a little over one-tenth of that amount. While in 1873 the amount of timber standing was estimated as 3,300 million feet B. M., in 1896 the State commissioner of forests places the remainder at 500 million feet B. M.

The only uncut White Pine forests of Pennsylvania now standing are isolated bodies in the more inaccessible parts of Clearfield, Lycoming, and Tioga counties.

In the State of New York, too, which in the Adirondacks and in the western counties contained considerable quantities of White Pine, the species is largely cut out. Hardly more than 5 per cent of the cut is now of White Pine, the output from the Adirondack mills being in the neighborhood of 25 million feet B. M.

The exploitation of White Pine in the Lake region began during the thirties, when small mills were erected at various points, both in Michigan and Wisconsin. The first steam sawmill at Saginaw was built in 1834, and the first mill at Alpena was built two years later. Nevertheless the lumber industry of both Michigan and Wisconsin remained insignificant until toward the close of the fifties, when most of the present sites of manufacture had been established. Ten years later (1870) the annual cut of White Pine in Michigan and Wisconsin amounted to nearly 4 billion feet; Minnesota had scarcely begun to contribute to the output; and in the marketing the railway was fast displacing the older method of rafting. The progress of lumbering is well illustrated in the following figures from the Northwestern Lumberman, representing the annual cut of lumber alone from 1873 to 1897:

Annual cut of lumber (exclusive of shingles and laths) of the three Lake States, Michigan, Wisconsin, and Minnesota, 1873–1897.

	Feet B. M.		Feet B. M.
1873	3,993,780,000	1886	7,425,368,443
1874	3,751,306,000	1887	7,757,916,781
1875	3,968,553,000	1888	8,388,716,460
1876	3,879,046,000	1889	8,305,833,277
1877	5,595,333,196	1890	8,664,504,715
1878	3,699,472,759	1891	7,943,137,012
1879	4,806,943,000	1892	8,903,748,423
1880	5,651,295,006	1893	7,599,748,458
1881	6,768,856,749	1894	6,763,110,619
1882	7,552,150,744	1895	7,093,398,598
1883	7,624,789,786	1896	5,725,763,035
1884	7,935,033,054	1897	6,233,454,000
1885	7,053,094,555		

Or, dividing the time into periods of five years each, the figures are as follows:

Cut of lumber (exclusive of shingles and laths) in Michigan, Wisconsin, and Minnesota, by periods of five years.

	Feet
1876–1880	21,562,090,361
1881–1885	36,933,924,888
1886–1890	40,542,339,679
1891–1895	38,302,113,140
Total	137,340,198,068

From the figures, to which about 10 per cent must be added for shingles, laths, etc., it appears that the yearly output did not reach 4 billion feet until 1879, and that the greatest increase in the cut occurred between 1876 and 1882, when the 7-billion mark was reached. This enormous cut continued until the general business depression of 1891 called a temporary halt. In Minnesota, pine lumbering began on the St. Croix and did not reach conspicuous dimensions until during the eighties, when the regions along the upper Mississippi, as well as the Duluth district, were opened. This progress westward is well illustrated by the following figures, which show the percentage of the total cut of lumber alone from period to period, by districts:

Percentage of total cut of lumber, 1873 to 1895, by districts.

Districts.	Lumber cut.				
	1873	1880	1885	1890	1895
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Saginaw district and mills along railways in southern peninsula of Michigan	36	31	27	24	16
Ports about Lake Michigan, including those of Green Bay	30	32	28	28	26
District west of Chicago, that is, most of the mills in Wisconsin and Minnesota	34	37	45	48	58

In this connection the White Pine trade of St. Louis presents an interesting illustration. The first pine lumber was received from Pittsburg in 1819, and this point remained the principal source of supplies for years. In 1843 a boom on the St. Croix River broke and the liberated logs were gathered and rafted to St. Louis, where they were sawn. In 1850 the first regular raft of Wisconsin logs was brought to the city. In 1853 Schulenberg and Boeckler built a large sawmill on the St. Croix, and from this time on rafts of sawed White Pine were sent to St. Louis from the northern rivers.

The receipts of White Pine at St. Louis were: In 1853, about 60 million feet; in 1882, about 162 million feet. Similarly the lumber trade of the city of Chicago, the greatest lumber market in the United States, if not in the world, illustrates well the development of the White Pine lumber industry. In 1847 only 32 million feet of White Pine lumber were received. The annual receipts at intervals of ten years since 1855 to 1895 were as follows:

	Feet.
1855	306,000,000
1865	647,145,734
1875	1,153,715,432
1885	1,744,892,000
1895	1,637,389,000

The receipts reached their maximum in 1892 with 2,203,874,000 feet, and the heavy diminution since that date is not greater than would be accounted for by the general business depression throughout the country.

In Canada, as in New England, the exploitation of White Pine began almost with the first settlement. Logs, hewn timbers, and especially ship spars, were exported in early days, and of late years an extensive trade in sawn lumber, as well as saw logs, has sprung up between that country and the United States. Since reliable statistics of the lumber output of this region are wanting, the following figures for the dues on crown timber in Ontario and Quebec must suffice to illustrate the development of the industry:

Average annual dues on crown timber for Ontario and Quebec.

1826–1834	$24,000
1835–1851	82,000
1852–1857	122,000
1858–1866	168,000
1867–1881	150,000

The export into the United States for 1894, the heaviest year, was: Lumber, 1,155 million feet (Pine and Spruce); pine logs, 277,917,000 feet, or less than 1½ billion feet B. M.

Though scattering White Pine occurs in all provinces of eastern Canada, large bodies of merchantable timber are only to be found on the upper waters of the Ottawa, and on the shores

of Lake Huron (Georgian Bay district) and Lake Superior, and the White Pine lumbering is practically confined to these districts. The output of White Pine in the Dominion is estimated at 1½ to 2 billion feet per year.

ORIGINAL STAND AND PRESENT SUPPLIES.

What the original stand of White Pine was is difficult even to estimate. The amount of White Pine cut in the New England States, New York, Pennsylvania, and the eastern Provinces of Canada is not known, and the only reliable figures which give an indication of what has been harvested are the figures for the Lake States above mentioned. For the Lake region alone the estimated original stand for Wisconsin may serve as an illustration. For the pine-stocked area of this State, a total stand of about 150 million feet per township (23,000 acres) has been shown to be a fair average. This would indicate a total of about 130 billion feet, of which about 66 billion feet were cut between 1873 and 1897, and about 20 billion feet are supposed to have been cut prior to 1873, making a total of about 86 billion feet as actually harvested, while about 18 billion feet were believed to be still standing in 1897. These figures are based upon a thorough canvass made by Mr. Filibert Roth and published in detail in Bulletin No. 16 of the Division of Forestry. On the same basis, Michigan possessed fully 150 billion feet and Minnesota may be assumed to have had about 70 billion feet, which would make an aggregate of about 350 billion feet of pine for the Lake States. Of this about 170 billion feet were cut between 1873 and 1897, and about 50 billion feet were probably cut prior to this time, accounting for about 220 billion feet out of 350 billion feet. While it must remain mere conjecture, it seems quite fair, nevertheless, to assume that the total supplies of White Pine aggregated probably not less than 700 billion feet of standing timber originally. Of this total, then, not less than 50 per cent was contained in Canada and the Eastern States, the United States portion representing about two-thirds of this heritage, the Canadian portion showing less than 20 per cent of total supplies.

Of this large amount of virgin supplies, a little over 15 per cent, or 100 billion feet, may be estimated as standing. These supplies may be approximately distributed as follows:

Canada is credited by the statistician of its department of agriculture with about 37 billion feet of standing pine, an estimate probably far below the real truth. For the Lake States the following estimates were made in 1897 by the best-informed man of the Lake region: Minnesota, 36 billion feet; Wisconsin, 18 billion feet; Michigan, 10 billion feet. These estimates are considered quite high by many. The standing pine in Michigan is placed by a detail township canvass in 1890 at only about 6 billion feet; the standing White Pine of Minnesota is estimated by the State chief fire warden at only about 12,600 million feet, while an estimate for Wisconsin made in 1895 places the standing pine of that State at only 8 billion feet.

Retaining the larger figures as probably the nearest correct, there exist to-day: In the Lake States, about 64 billion feet; in Canada, over 40 billion feet; in New York and Pennsylvania, not over 2 billion feet; in New England, not over 3 billion feet; in West Virginia and Tennessee, not over 1 billion feet; making a total of about 110 billion feet, or about 22 per cent of what may fairly be believed to have been standing originally. Of this standing supply, about 100 billion feet are so located that the present rate of exploitation (over 6 billion feet per year) can be, and probably will be, continued until over 75 per cent of the present supply is cut, when, of course, a lack of logs will lead to a reduction in output. This condition may be looked for before the end of the next ten or twenty years, and from that time, unless recuperative measures are adopted, White Pine will cease to be the great staple of our lumber markets.

In former years lumbering of all kinds was careless, and even in the White Pine forests the prevailing "inexhaustible supply" notion led to enormous waste. Stumps were left 3 to 4 feet high, all defective trees were left, and top logs burned up with the débris. Many of these old slashings have been logged for the second and even the third time, often yielding a greater profit than when first culled.

At present this is no longer the case. High stumpage prices and a perfect market have led to the closest economy in logging, milling, and shipping of White Pine. The trees are felled with the saw, the stumps are 18 inches and less, care is had in the marking and sawing of logs, and the top is utilized, irrespective of knots, just as far as it will make saw timber. Defective logs

are rarely left behind, and "clean cutting" now means the removal of all logs, however defective. In logging, ice roads, improved by nightly sprinkling, enable the transport of enormous loads (5,000 feet and more) by single or double teams. The logging railway is fast finding favor, and in many places the logging is thereby made continuous, being carried on at all seasons. (See Pl. IV.)

The yields in White Pine are, as might be expected, very variable.

A cut of 2 million feet B. M. on a "forty," or 50,000 feet per acre, was not a rare one in the pineries of southern Michigan, and occasionally such cuts are made in Wisconsin and Minnesota. To yield such a result the entire "forty" must be well and evenly stocked. The best acre, then, need not be far above the average, and, in fact, rarely exceeds 75,000 feet.

A stand of 1 million feet on a "forty," or 25,000 feet per acre, is a good one, but was of quite common occurrence in all White Pine districts, and may still be found in many places, while whole townships or counties have averaged 10,000 feet per acre.

These yields depend, of course, on the character of the forest growth, the greater or smaller admixture of other species occasioning the differences. Thus, if any large territory of the pine districts were taken into consideration, a yield of 150 million feet per township would be found a fair statement for most parts of the pineries of Wisconsin and Michigan.

The best yields do not usually come from those tracts which contain the largest trees, but where the pine is least mixed with other species and stands most dense.

Such areas, pineries proper, where no merchantable hardwoods were mixed with the pine, are usually tracts of loamy sand, and occur in extensive bodies in all three of the Lake States. Generally, White Pine cuts more wasteful than Norway or Red Pine, has a thicker bark, more large dead limbs and knots, these latter often coming to within 20 feet of the ground, even on large trees, and is quite given to forking. This latter peculiarity seems natural to the tree, and has been observed abroad as well as here. It seems independent of the character of the soil, as it occurs on clay and sand alike, but it is often localized, so that on a small tract of 10 or 20 acres nearly all trees are forked. Trees with three and four forks are not rare, and five forks occur. In addition, White Pine is extensively defective by decay, so much so that in some localities 15 to 20 per cent must be allowed for the loss from this source.

NATURAL HISTORY.

The oldest description of the White Pine appears to be that of Plukenet, published in 1700. Its scientific name of *Pinus strobus* was given the species by Linnæus in 1753, and unlike most trees but one other scientific name has been applied to it, the synonym being *Pinus tenuifolia* Salisbury, 1796. Besides the generally accepted common name of White Pine, the species is locally known in the United States as Soft Pine, Northern Pine, and Spruce Pine, and to a limited extent by its usual European name of Weymouth Pine.

The species was first introduced in Europe at Badminton, England, and was soon after extensively planted on the estate of Lord Weymouth, whence its common name abroad. It was also extensively planted in Germany at the end of the last century under the same name, Weymuthkiefer.

BOTANICAL DESCRIPTION.

White Pine (*Pinus strobus* L.) in its natural habitat is a tree of large size, 100 feet or more in height (not unfrequently attaining a height of over 150 feet, even trees of 250 feet in height having been reported), with smooth, thin, grayish bark (fig. 1), becoming at the base thick and deeply furrowed with age. The leaves are slender, straight, triangular in section, five in a sheath, 2½ to 4½ inches long; resin ducts, chiefly two near the dorsal face; stomata in three to five rows on the ventral faces; fibro-vascular bundle, one. Cones, single or in groups of two to three, stalked and pendulous, 4 to 6 inches long, cylindrical, slightly tapering and curved, fruit-scales oblong wedge-shaped, the apophysis half pyramidal, with a triangular blunt point. Seeds, one-fifth to one-fourth inch long, grayish-brown, with a thin membranaceous wing. Cotyledons, seven to eleven.

A number of varieties, more or less distinctly marked, are recognized in cultivation. Among these are *nana*, a dwarf, bushy form, cultivated in gardens in the Old World; *nivea*, *viridis*, and *aurea*, named from the color of their leaves; *brevifolia*, and several others (*umbraculifera*, *minima*,

FIG. 1.—TRANSPORTING LOGS OVER ICE ROAD IN MICHIGAN.

FIG. 2.—LUMBER CAMP IN MICHIGAN.

fastigiata, *gracilifolia*, *variegata*, *zebrina*, and *prostrata*), some of which are propagated and sold as special attractions in nurseries.

RELATIONSHIP.

The White Pine (*Pinus strobus*) is closely related to the Bhotan Pine (*Pinus excelsa*) of India, the Swiss Stone Pine (*Pinus cembra*) of southern Europe, the White Pine (*Pinus flexilis*) of the Rocky Mountains, the Sugar Pine (*Pinus lambertiana*) of the Pacific coast, and a number of others less generally known, of which *Pinus monticola*, *P. albicaulis*, *P. strobiformis*, *P. quadrifolia*, *P. parryana*, and *P. cembroides* are natives of the United States.

The species belonging to this section of the pine genus are distinguished by their slender, delicate leaves, five in a sheath; by the exceptionally soft and even texture of their wood, and by certain well-defined botanical characters, by which they are marked as a natural and easily recognized group.

The group of species just named shows a preference, generally characteristic of this section of pines, for elevated, mountain regions, and a light rather than a heavy soil, making, as a rule, a healthy growth on sandy and rocky places, and manifestly preferring these to low and heavy soil. All are handsome trees, symmetrical in form, some of them, as the Sugar Pine (*Pinus lambertiana*), of rapid growth, and forming magnificent specimens from 150 to over 200 feet in height, while others are of slow growth, as the Stone Pine of the Alps, which produces, however, a beautiful, fine-grained wood, extensively used by the Swiss peasants for carving. The Bhotan Pine of the Himalayas is the representative of the White Pine in Asia, resembling it very closely in habit, size, structure of wood, and various technical characters.

Fig. 1.—Bark of old White Pine.

Admitting the common ancestry of these various species, a more extended comparative study of their preferences and habits would be of much interest in relation to their cultivation beyond their natural range, considering the fact that, whatever their environment, such ancestral traits are certain to manifest themselves.

MORPHOLOGICAL CHARACTERS.

ROOT, STEM, AND BRANCH SYSTEM.

In the natural forest, with a due amount of shade, the White Pine has at maturity a straight columnar trunk, destitute of branches for half to two-thirds of the distance from the ground to the tip of the leader.

The branches are for many years disposed regularly in whorls, and during this early period the tree retains a symmetrical, conical form, and is one of the most graceful of the pines for ornamental cultivation, but, as is the case with other conifers, the lower branches are short lived, and ultimately, by their decay, the tree becomes unsightly. This fact, which renders this species, in common with all other conifers, undesirable during part of their lifetime for ornamental purposes, gives it the greater value as a timber tree.

The crown, at first pyramidal, is finally less regular, although rarely flattening, and, owing to the rapid and persistent growth of the tree, conspicuously overtops the surrounding forest of deciduous trees. The root system is small compared with the size of the tree and spreads near the surface of the ground; its comparatively slight development is in harmony with the less pronounced dependence of this species on the soil and its greater dependence on the atmosphere.

Nursery seedlings produce numerous slender, fibrous roots, the delicate tissues of which are as in most conifers easily dried at the time of transplanting, resulting in very serious injury or loss of plant material. White Pines planted upon the dry sand along the Lake Michigan shore and trimmed of their lower branches have been observed restoring these lower limbs and forming a thick, green covering over the roots before making any height growth, suggesting in a striking manner the necessity of protecting the root system against too rapid evaporation and a too highly heated soil. In the natural forest, and in artificial groves properly planted, the fallen leaves fulfill this function by making a deep, thick coating over the roots.

LEAVES.

The leaves arise from greatly reduced short branchlets and are produced five together, surrounded at the base by a thin deciduous sheath, and are further distinguished by being more slender and delicate than those of our other native pines. (Pl. V, *1*, *2*, *3*, *4*.) The relative position of the five leaves inclosed in their common sheath is shown in Pl. V, *5*, and in Pl. V, *6*, is represented a cross section of a single leaf, magnified sufficiently to show the characteristic arrangement of the tissues.

Without entering into a detailed account of its functions, which would here be irrelevant, it may nevertheless be remarked that the leaf of the White Pine constitutes a highly complicated and delicate piece of apparatus. Like all foliage leaves, the leaf of the White Pine fulfills the important functions of respiration and the manufacture of starchy food, during which processes large amounts of watery vapor are exhaled.

A healthy pine seedling, three years old, in the air of a dry room, lost by evaporation in twenty-four hours 81.1 per cent and in the following twenty-five hours 96.7 per cent of its entire dry weight.[1] The evaporation, chiefly through the leaves, is more rapid in the daytime than in the night, in clear than in cloudy weather, and most rapid of all in a drying wind. It will readily be seen that if a tree is planted on a clear, dry, and windy day, the conditions are the most unfavorable that could possibly be chosen, the rapid evaporation carrying off the water of the plant beyond the capacity of the roots, not yet adapted to their new place, to meet the demand, which results in the drying up of the tissues and often in the death of the tree.

The various forms of modified leaves are characterized by extreme delicacy. Winter buds (Pl. V, *7*), with their thin and small scales, present a striking contrast to those of Longleaf Pine, for example, and other species that produce large buds with relatively thick and coarse scales. The very loose leaf sheaths and scale-like leaves of the young shoots are early deciduous, a fact that contributes to the growth of the smooth, clean bark characteristic of the branches of White Pine, in which it differs in so marked a way from the species of the Yellow Pine group.

In Pl. V, *1*, the modified, scale-like leaves that constitute the loose sheaths are conspicuously shown. Separate fascicles, with their sheaths, are represented in Pl. V at *2* and *3*, while at *4* is an older one as it appears at the end of the summer after the sheath has fallen.

EXPLANATION OF PLATE V.

1. Shoot showing foliage and scale leaves of different ages.
2. Young fascicle with sheath.
3. Young fascicle further developed.
4. Still older fascicle from which the deciduous sheath has fallen.
5. Section of fascicle inclosed in sheath.
6. Section of leaf magnified.
7. Winter bud.

FLORAL ORGANS.

Flowers and fruit are rarely produced to any considerable extent before the tree has attained the age of fifteen or twenty years, though occasionally trees may bear fruit at ten to twelve years of age.

The staminate and pistillate flowers are separate, but produced on the same tree. They appear in May, the pollen ripening and pollination taking place (in the latitude of Ann Arbor,

[1] According to determinations made in the botanical laboratory of the University of Michigan, November 18, 1886.

LEAVES AND BUD OF THE WHITE PINE.

CONES, SEEDS, ETC., OF THE WHITE PINE.

Mich.) between the middle and the end of the month. The staminate flowers are borne laterally on the shoots of the season (Pl. VI, *1*). They are extremely simple in structure, consisting of numerous pollen sacs borne in pairs on the outer face of the scale-like staminal leaves. The pollen is produced in great abundance and is carried by the wind to great distances. Fertilization, however, notwithstanding the profuse production of pollen, often fails to take place. In fact, failure appears to be rather the rule than the exception, if we consider the frequency of "off years," in which little, if any, good seed is produced. But doubtless other causes often combine to prevent the production of a full crop of seeds.

The pistillate flowers occupy the apex of the young shoot (Pl. VI, *2*), finally forming a bunch of cones pendent from the ends of the branches. At the time of pollination they are about one-fourth of an inch in length and have the appearance of minute fleshy cones, which by the end of the first summer's growth have attained the length of three-fourths of an inch to an inch, and have the appearance represented in Pl. VI, *3*. They are not ripe until the fall of the succeeding year, when the cones, having now attained their full size, as shown in Pl. VI, *5* and *6*, open and allow the winged seeds to escape. In order to prevent loss of seeds it is necessary to gather the cones a little before they ripen, which occurs during early September in most localities of the natural range. Afterwards, if kept in a dry place, they will open readily themselves and allow the seeds to fall out. The ripening is signalized by the change of color to a yellow brown and the forming of a resin coat.

SEEDS.

The seeds are one-fourth of an inch in length by about half that measure in breadth, of an oval form, grayish-brown in color, sprinkled with darker spots, and provided with a thin, delicate wing, by means of which they are disseminated through the agency of the wind (Pl. VI, *8*). The seed coats consist of a hard outer shell, or testa, inside of which is a thinner membrane, the endopleura. Inside of the seed coats is the whitish endosperm, constituting the food of the germinating plant, within which, occupying the center of the seed, is the small, straight embryo, the three parts of which, stem, radicle, and cotyledons, are plainly distinguishable.

To get 1 pound of seed from 2 to 2½ bushels of cones are necessary.

Concerning the production of seed, the experience in this country is but fragmentary. The individual tree begins to bear quite early. Isolated specimens, or trees in open groves, bear cones before they are twenty years old, and even trees in the dense forest seem to bear generally before they are forty years of age. The capacity to bear abundantly is retained to old age, the oldest trees seen still bearing heavily, and even mutilation by fire or otherwise does not prevent the trees from bearing.

EXPLANATION OF PLATE VI.

1. Staminate flowers of *Pinus strobus* just before shedding of pollen.
2. Pistillate flowers, terminating young shoot.
3. Young cones in autumn of first year.
4. Young cones early in summer of second year.
5. Cones at close of second year's growth before opening of scales.
6. Mature cone, the scales separated to admit of dissemination of seeds.
7. Single scale, showing outer surface.
8. Single scale, showing inner surface with seeds in place.

SEED SUPPLY.

A full crop of seeds is usually produced by the same tree only at intervals of several years. Cones may be formed year after year, but upon examination it is often found that many of the seeds are abortive. Of a large number of cones gathered at Ann Arbor, Mich., in 1886, not a single one showed a perfect seed. Mr. John E. Hobbs states that the same year (1886) was a good seed year in Maine, and that trees had not produced so largely before since 1879. According to Mr. J. Dawson, of the Arnold Arboretum, a crop of seed may be looked for about once in five years, though others make intervals between seed years shorter. The frequency of seed years has not been sufficiently noted as yet to warrant any general statement, but it is known that during certain seasons the seed production is perfectly general over large areas, while in other years it is not. Thus, in 1897 the White Pine bore heavily in every pine county in northern Wisconsin.

The frequency of seed years varies of course not only on account of more or less favorable seasons, but according to locality and climatic conditions. In Europe the White Pine is regarded as a frequent and heavy seeder, one year out of three being generally productive. A grove of 8 acres near Frankfort on the Main produced during twenty years, on an average, $100 worth of seed, with a maximum yield of $500, and with but three "off" or fail years in the twenty. Similarly an area of about 40 acres in the Palatinate furnishes as high as 1,700 bushels of cones, or about 1,300 pounds of seed, supplying all the nurseries of the Palatinate State forests with seed.

THE WOOD.

The structure and development of the wood of the White Pine may be studied to the best advantage by beginning with a young shoot cut from a vigorous tree in early summer. A cross section of such a shoot in the first season of its growth (Pl. VII, *1*) shows three plainly marked zones—the pith (*m*) surrounded by the wood (*x*) and the inner bark (*ph*), which together form the conspicuous zone crossed by radiating bands, the so-called medullary rays, and outside of the parts just described, a broad zone of cellular tissue, constituting the middle bark, which is bounded externally by the epidermis.

The pith, medullary rays, and middle bark consist of simple cells, originally of an irregularly rounded form. Together they constitute the so-called ground tissue of the stem, as distinguished from the fibro-vascular portion, which includes the wood and inner bark.

Within the cortical portion of the ground tissue numerous large openings (Pl. VII, *1*, *rd*) are seen, of different sizes and apparently without definite arrangement. These are the resin ducts. Each duct runs longitudinally through the stem, and consists of a central cavity filled with resin, around which is a single layer of secreting cells, easily distinguished by the nature of their contents from the surrounding cells of the cortex. At this stage of development the resin ducts are confined to the cortical parenchyma, none having yet been formed in the woody portion of the stem; but later in the season, as may be seen in older sections, a number of ducts are formed, arranged in a circle near the periphery of the wood. These have essentially the same structure as those of the cortex, but are of smaller size and are surrounded by fewer secreting cells. In cross sections of older stems the resin ducts are seen, arranged in an irregular circle, in each annual ring. Their physiological significance is not fully understood, though there can be little doubt that De Vries is correct in assuming that the abundant resin is of service to the growing tree, when wounded, in preventing decay of the wood, and that its preservative influence is continued after the tree has been cut into lumber.

In such a young shoot as has been described the cells are vitally active, and are filled with granular protoplasm, in addition to which several other substances are either produced or stored up in them, particularly in the cells belonging to the ground tissue. Chlorophyll occurs in the pith and medullary rays as well as in the cortical portion. It is most abundant in the cells of the cortical parenchyma, occurring in the form of minute grains, irregular in shape and size. Starch, in rounded granules, occurs abundantly throughout the ground tissue, the cells of the cortex containing a larger proportion than those of the pith. Resin, as already stated, fills the resin ducts and the secreting cells around them, though starch is often found in the latter.

Passing now to the woody portion immediately surrounding the pith, two characteristic features at once attract attention. The elements composing the wood, *x* (Pl. VII, *1* and *3*), have a much narrower lumen than those of the pith, and are regularly disposed in radiating rows. These elements, the tracheids, are elongated thick-walled cells, four to six sided, according to the number of tracheids by which they are surrounded. Their walls are lignified and are marked by the peculiar structures called bordered pits. Their structure, when fully developed, is shown in Pl. VIII, *1*, *2*, and *4*. In the economy of the tree the wood fulfills the function of mechanical support, and serves as the conducting tissue through which the water, evaporated from the leaves, is carried up from the roots.

The medullary rays are composed of cells so flattened by the pressure of the tracheids that on longitudinal sections they appear as represented in Pl. VIII, *3*. They contain a conspicuous nucleus, are closely packed with granular food substances, and serve collectively as a storehouse

of reserve materials. Communication between these and the tracheids is effected by means of simple pits on their radial walls.

The inner bark, or phloem, *ph* (Pl. VII, *1* and *3*), closely resembles the young wood on cross section, its elements being arranged in radiating rows and traversed in like manner by the medullary rays. The cells composing it differ, however, in various important particulars from those of the wood. Their walls are of cellulose, and although important as conducting tissue, they contribute comparatively little to the rigidity of the stem.

Between the wood and inner bark is the cambium or formative tissue, represented in Pl. VII, *1*, as a light band of extremely small and delicate cells, and in the same plate as a zone of cells with thin walls and large lumen, contrasting strongly with the wood elements and those of the inner bark between which they lie. It is from the cells of the cambium that those of the wood are formed on the one hand and those of the bark on the other. The process is a gradual one, and no absolute line of demarcation can be drawn between the cambium and the tissues derived from it. The cells of the cambium multiply by tangential division. The essential features of this process, as regards the position of the cell walls, are represented in Pl. VIII, *1*, in which the lightest lines represent the youngest walls and the heavier ones those of greater age, successively. It is by the constant repetition of this process of tangential division and the subsequent thickening of the walls of the cells thus formed that the wood and inner bark make their yearly increase in thickness. In the spring the cells of the cambium are large and vigorous, and a rapid formation of wood elements with relatively thin walls and large cavities takes place, while later in the season much smaller tracheids with thicker walls are formed. This results in the strong contrast between the wood last produced in any given year and that formed at the beginning of the next season's growth, giving rise to the sharp distinction of annual rings so clearly brought out in Pl. VIII, *1*.

The histological characters thus briefly summarized hold true, in a general way, for other conifers as well as the White Pine. This species, however, presents a number of peculiarities that are of both physiological and economical interest.

The resin ducts of the White Pine are larger and more numerous in the cortex than in the wood, an arrangement well adapted to secure the protective action of the resin contained in them without introducing an element of weakness into the wood. Comparisons with other species bring out this fact in a striking manner. Thus, upon comparing the distribution of the resin ducts in stems of the White and Scotch pines, as nearly alike as possible, it was found that in the cortex of White Pine stems of one year's growth the number of resin passages ranged from 20 to 47, the average being about 33. The number in the wood was more uniform and averaged about 13. In the Scotch Pine the average for the wood was found to be 33 and for the cortex 10. Taking the second year's growth in the same way, the average number for cortex of White Pine in the specimens examined was 28 and for wood 27; in Scotch Pine, for cortex 9 and for wood 37.[1] The small size of the resin ducts in the wood contrasts strongly with the very large ones of Scotch Pine, which seriously interfere with the continuity of the wood and tend both to weaken it and to give it an uneven texture.

The extremely small number of thick-walled tracheids constituting the summer wood of the White Pine is in marked contrast with the broad band of summer wood formed in various other species. Comparing the annual rings of White Pine with those of Longleaf Pine, for example, it is seen that while the thick-walled tracheids of the former make hardly more than the mere outer edge of each ring, those of the latter constitute one-third or more of its entire width. Moreover, the gradual, almost imperceptible, transition from spring to summer wood in the White Pine contrasts strongly with the abrupt line of demarcation seen in Longleaf Pine and all other Yellow Pines. It is to this very gradual transition that the uniform texture of the wood of White Pine is chiefly due. The medullary rays of the different groups of pines show certain structural peculiarities that appear to be constant for the group of species in which they occur. The writer is indebted to Mr. Filibert Roth for the following notes in regard to this feature:

In all pines the medullary ray is made up of two kinds of cells which differ in their general form, and still more in the configuration of the cell wall and pits. The one kind occupies the upper and lower rows of each ray,

[1] Etta L. Knowles, in Botanical Gazette, August, 1886.

and are therefore termed the outer cells; the other kind makes up the intermediate rows and are known as the inner cells.

In the appearance of both outer and inner cells there is a marked and constant difference in different groups of pines. While the interior of the wall of the outer cells (transverse tracheids) is smooth in some groups, it is beset with numerous bold projections in others. Similarly the inner cells (parenchyma) of the spring wood of each ray in some groups have but a single large pit communicating with the neighboring tracheid, while in other groups this is brought about by three to six smaller pits.

Based upon these differences, the following classification of the wood of different species of pines is proposed by Dr. J. Schroeder:[1]

SECTION I. Walls of the tracheids of the pith ray with dentate projections.

a. One to two large, simple pits to each tracheid on the radial walls of the cells of the pith ray. Group 1. Represented in this country only by *P. resinosa*.

b. Three to six simple pits to each tracheid, on the walls of the cells of the pith ray.—Group 2. *P. taeda, palustris*, etc., including most of our "hard" and "yellow" pines.

SECTION II. Walls of tracheids of pith ray smooth, without dentate projections.

a. One or two large pits to each tracheid on the radial walls of each cell of the pith ray.—Group 3. *P. strobus, lambertiana*, and other true White Pines.

b. Three to six small pits on the radial walls of each cell of the pith ray.—Group 4. *P. parryana*, and other nut pines, including also *P. balfouriana*.

Returning to the medullary ray of the White Pine, it is observed that the walls of the outer cells are thin (1.5 μ to 2 μ); the round pits quite variable in number and size, but always as small, and often smaller, than the pits of the tracheids in the summer wood; also that the walls of the inner cells are thin (1.5 μ to 3 μ), for the most part very thin, being largely occupied by pits; that the pits are large ovals on the radial walls of the cells in the spring wood, small erect ovals in the summer wood, and small and irregular in outline above and below where the inner cells communicate with each other. The length of these cells varies, even in the same ray, between 50 μ and 300 μ; the width was found to be about 7 μ for the outer and 12 μ for the inner cells; the height, more variable in the outer than in the inner cells, and less variable than either width or length, may be set at about 23 μ for outer and inner cells. The average number of cell rows in one medullary ray, for the specimens studied, is 7.5, whereof 2.6 fall to the outer cells and 4.9 to the inner cells. The limits of the total number of cell rows were 2 and 16; the height of the ray, therefore, 46 μ to 368 μ, dimensions scarcely appreciable to the unaided eye. What is lost in size is gained in number; on an average 21.3 medullary rays were counted on 1 square millimeter, or 13,312 to 1 square inch of tangential section.

A study of the wood in its physical and mechanical properties, by Mr. Filibert Roth, will be found further on in this monograph.

EXPLANATION OF PLATE VII.

1. Transverse section of fresh shoot, cut in summer of first year × 25. The zone of small cells surrounding the pith includes the wood and inner bark, both of which are traversed radially by the medullary rays. The thick cortical parenchyma outside of these is marked by the presence of a number of large resin ducts.

2. Portion of epidermis, with appendages. Beneath the epidermis a few cells of the cortical parenchyma containing starch.

3. Highly magnified view of a part of the transverse section, showing the structure of wood and inner bark, with the thin-walled cells composing the cambium lying between them.

[Figs. 2 and 3 were drawn with great care with the camera, but unfortunately no statement of the magnification was preserved with them.]

EXPLANATION OF PLATE VIII.

1. Cross section of wood × 175. The section includes parts of three medullary rays, the middle one of which is cut partly through the inner cells and partly through the cross tracheids. The gradual transition from spring to summer wood is clearly shown. Part of a resin duct is seen on the right.

2. Radial longitudinal section of wood × 200, showing a few of the thick-walled tracheids of the summer wood followed by the large thin-walled ones of the succeeding spring, both crossed by a medullary ray. The bordered pits of the outer cells of the ray, shown both in section and surface view, are in strong contrast with the simple pits of the inner cells.

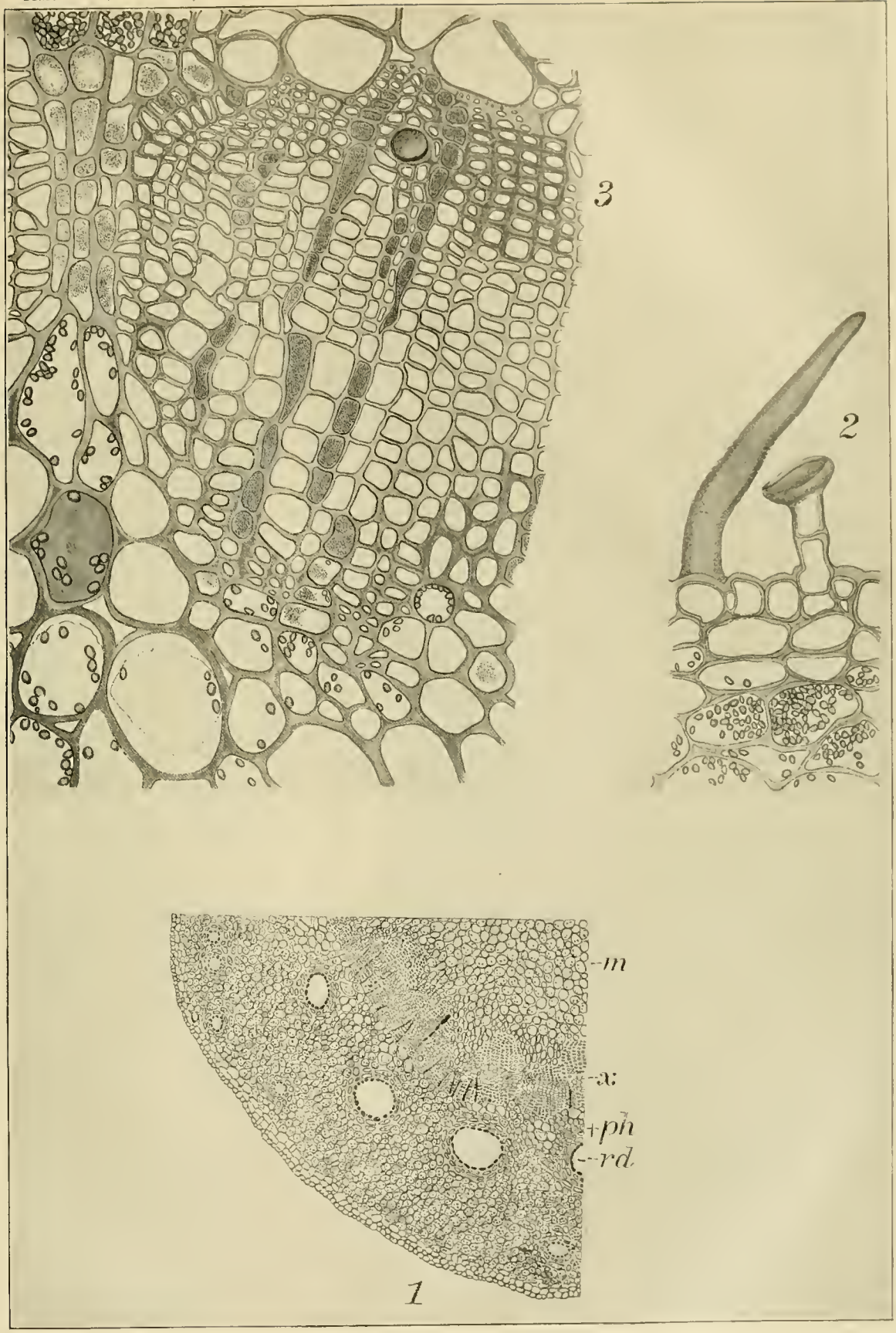
3. Tangential section of wood × 200.

4. Cross section of part of twig collected May 20, 1886, × 175, showing cambium and development of wood and bark. The woody ring is about one-third its final thickness.

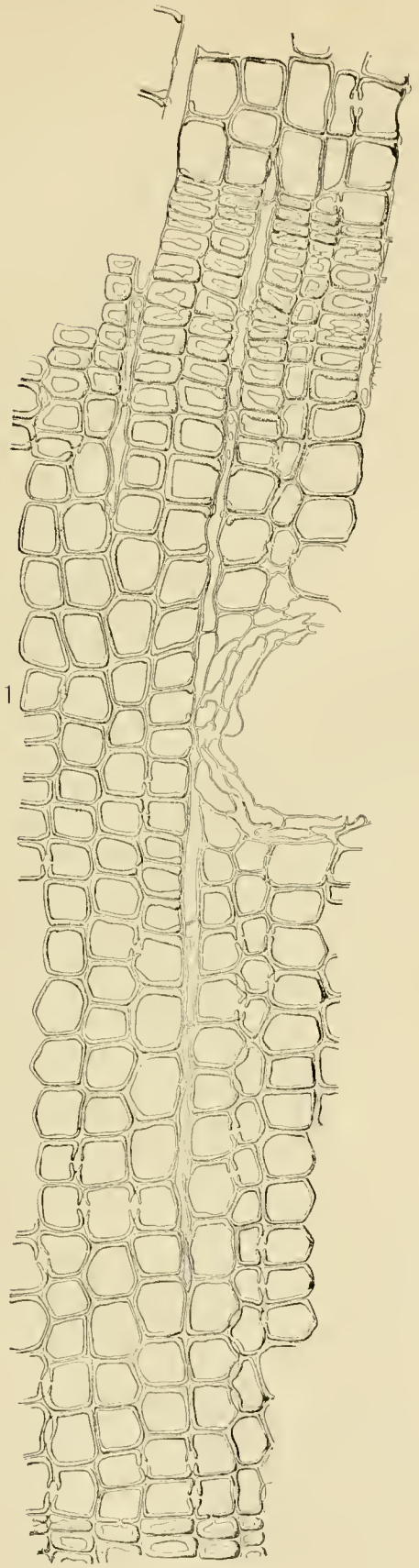
GROWTH AND DEVELOPMENT.

The seeds of the White Pine retain their vitality for a long period. Trustworthy observers state that a fair percentage will grow after being kept five years or more. The conditions of germination and successful growth are, in general, the same as for other pines, namely, a suitable

[1] Dr. J. Schroeder, Das Holz der Coniferen, 1872.



SECTIONS OF YOUNG SHOOT OF WHITE PINE.



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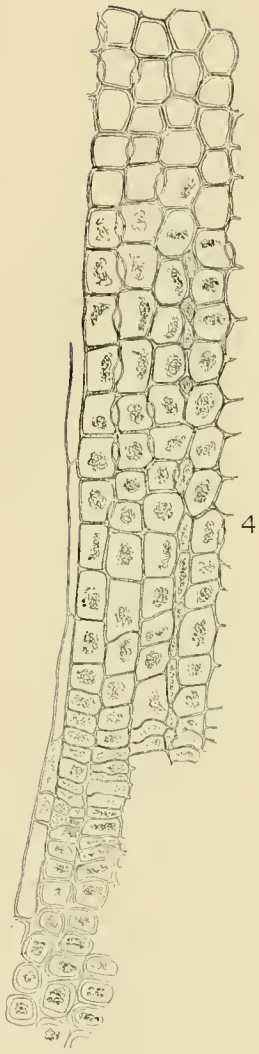

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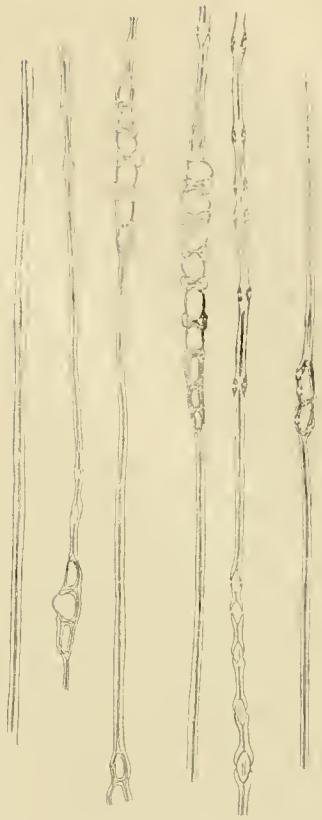

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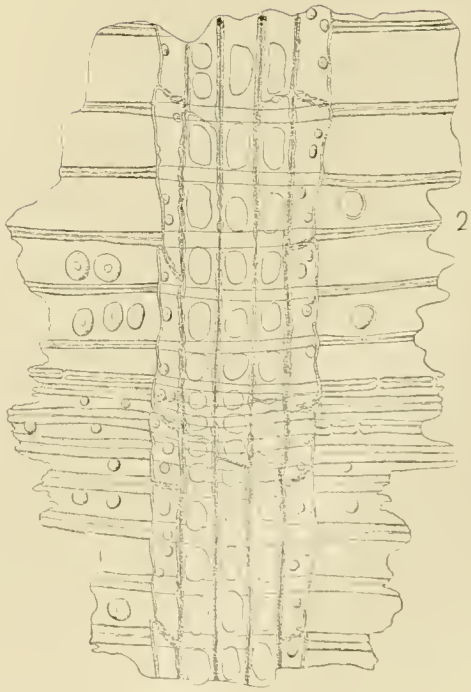

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SECTIONS OF WOOD OF WHITE PINE.

SEEDLINGS OF WHITE PINE.

soil, moderately warm and moist (not wet), in which the seeds are covered at a depth not exceeding twice their own diameter, and, further, protection of the young seedlings against the hot sun and drying winds. Special attention is required in the nursery to avoid undue moisture when the seedlings appear above the ground, as they are often attacked by a destructive disease very common in propagating beds, known as "damping off." If, however, no adverse influences have interfered with its normal development, the young plant presents itself after some months' growth as a slender shoot, crowned by the persistent seed leaves, in the midst of which is the terminal bud, the latter having already formed numerous short foliage leaves. No branches have appeared, and the foliage leaves arise singly instead of in groups of five. The whole plant, as it appears at this time, with its slender stem and long taproot, is represented, natural size, in Pl. IX, drawn from a specimen obtained in the pine woods of Michigan, in September, 1886. Earlier and later stages of development of the seedlings are shown in the same plate (*1*, *2*, *3*, *4*, *5*, *6*) drawn from nursery specimens.

For the first two or three years the growth of the seedling is slow, and is so greatly influenced by its surroundings as to make it impossible to give averages that will fairly represent the yearly increase in height and diameter.

Thus, a healthy seedling, three years old, from the nursery row, measured 4.6 inches, while a self-sown specimen from Maine, four years old, measured only 2.7 inches in height. But, if the circumstances are favorable, after the third year a growth of one to several inches is made each year, and from this time on the yearly increase in height is clearly defined by alternating nodes and internodes, a whorl of branches being formed at each node.

The leading shoot is from the first the most conspicuous and the most important part of the plant, branches being manifestly subordinate, dying off in later years as in other conifers. The rate of growth being of most important practical interest, much space has been devoted to this part of the developmental history.

The tree rarely reaches a height of more than 160 feet and diameters of more than 40 inches, more usually 30 inches. Occasionally these dimensions are exceeded; trees of 200 feet in height and of 60 inches in diameter have been reported. The largest actually measured by the Division of Forestry was 48 inches in diameter breast high and 170 feet in height, with an age of about four hundred and sixty years, containing 738 cubic feet of wood, standing in a group of similarly old and large pines in Michigan. Another tree of this group, with 47 inches diameter and 162 feet in height, contained 855 cubic feet, being less tapered.

EXPLANATION OF PLATE IX.

1. Seedling as it first appears with seed coat attached to seed leaves.
2. Seedling with seed coat detached.
3. Seedling with seed leaves and primary foliage leaves disposed singly on stem; five months old.
4. Seedling in its second year, showing primary leaves and secondary leaves (mature form), the latter in clusters of five.
5 and *6*. Seedlings three to five years old.

RATE OF GROWTH.

The following statements regarding the progress and rate of growth of White Pine are based mainly upon the very comprehensive data collected by the Division of Forestry in Maine, New Hampshire, Massachusetts, Pennsylvania, Michigan, and Wisconsin. These data, involving measurements and detailed analyses of over seven hundred trees grown under varying conditions, together with records of the conditions under which they grew, and the amounts of timber which were produced under such conditions per acre, are presented fully in the tables, with accompanying notes, in the Appendix to this monograph. It appeared, however, desirable to present in the text not only the generalizations and conclusions, but also some typical cases. Some other measurements, made before this comprehensive investigation and recorded by the writer in his original manuscript, are also produced.

HEIGHT GROWTH.

SEEDLING STAGE.

The growth of the seedling is variable, according to the conditions under which it grows. In the forest it is much slower than under cultivation, as would naturally be expected. The common

practice of nurserymen is to sow the seed broadcast in carefully prepared beds, where the seedlings stand from two to four years before transplanting. Standing very close, the trees do not make as stocky growth as they otherwise would. Under these conditions the average growth of untransplanted seedlings, according to statements by the well-known nurserymen, Thomas Meehan & Sons, is as follows: One year seedlings, 2 to 3 inches high; two years, 4 to 6 inches; three years, 12 to 15 inches; four years, 24 to 36 inches.

The late Mr. Robert Douglas, the veteran nurseryman, of Waukegan, Ill., wrote:

> White Pine seedlings one year old are 1 to 2 inches high and altogether too small and tender for transplanting. At two years old they are much stronger, from 3 to 5 inches high, with fine fibrous roots and in fine condition for transplanting. At three years old they are 6 to 9 inches high and should not be allowed to stand another year, as they would add about 10 inches to their height during the next year and would not be suitable for planting.
>
> The first season after transplanting, the White Pine (like other trees) will not increase much in height, but will establish itself, extending its roots and forming a strong terminal bud, so that when it is six years old it will exceed in weight and bulk over one hundred times its proportions when transplanted, and thereafter will increase in growth from 18 to 30 inches in height annually in good soil for many years.

Gardner & Sons, whose nursery is about 90 miles west of the Mississippi River, in Iowa, and therefore outside of the natural range of the species, submit the following measurements, coinciding with the above, as representing average growths at their nurseries before and after transplanting: One-year-old seedling, 1½ inches high; two-year-old seedling, 4 inches high; three year-old seedling, 7 inches high. The trees are transplanted at three years of age and thereafter the average height for the three following seasons are: Four years old, 12 inches high; five years old, 16 inches high; six years old, 33 inches high. Another establishment reports as the average height of two year-old trees in seed bed, 3½ inches; of three-year seedlings, 7 inches.

Casual observations and measurements of some forty-five seedlings in the forest permit the following as to the height growth of seedlings in the forest:

Height growth of White Pine in the forest for the first six years.

Age of seedlings.	Height of stem.			Current annual accretion.
	From—	To—	Average.	
	Inches.	*Inches.*	*Inches.*	*Inches.*
1 year	1	2	1½	.....
2 years	2	4	3	2
3 years	3	7½	5	2
4 years	6	10	8	3
5 years	10	12	11½	3½
6 years	30	34	31½	20

These measurements show that the rapid height growth begins with the sixth year, when the total growth of the first five years is almost doubled in one season. This, to be sure, holds only for seedlings favorably situated. In those less favored the rapid stage of development comes more gradually. This slow progress in younger years is naturally reflected in a retardation of the year of maximum height growth, which in dominant trees occurs about the twentieth year, while in oppressed trees it may not come before the fortieth year.

DEVELOPMENT IN OPEN STAND.

Trees on lawns and in pastures, which grow up in full enjoyment of light, are somewhat different from trees in the forest. The slow seedling stage is followed by a very rapid increase in the rate, which attains its maximum before the twentieth year and then declines gradually.

Table I, on the next page, presents a complete record from year to year of the growth of eight trees planted on a lawn at Ann Arbor, Mich., which were measured in 1886, the annual increase being measured between the whorls of branches. These measurements also exhibit the great variability of growth from season to season and from tree to tree, even under otherwise similar conditions. In some of the trees, evidently, injuries or accidents retarded development. Such apparent deficiencies have been left out of consideration in averaging the data.

TABLE I.—*Height growth of White Pine planted in lawn at Ann Arbor, Mich., by years, in inches.*

Number of tree.	Age.	Diameter breast high.	Height.	Height, by years.																							
				1 to 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	Yrs.	*Inches.*	*Feet.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
1	17	5.1	30.5	26	15	22	21	23	28	39	37	39	39	39	39	39	...	...	...	...	...	...	...	...	...	...	...	...	...
2	19	3.8	23.5	20	3	5	11	16	11	19	24	33	32	35	28	24	21	...	...	...	...	...	...	...	...	...	...	...	...
3	19	6	30.5	25	10	4	14	32	24	23	23	32	35	32	36	26	32	...	...	...	...	...	...	...	...	...	...	...	...
4	21	6	26.6	41	6	12	24	23	18	26	23	5	29	25	5	19	20	25	19	...	...	...	...	...	...	...	...	...	...
5	23	8.2	34.5	33	12	14	14	20	40	29	20	37	30	10	32	30	7	26	24	21	15	...	...	...	...	...	...	...	...
6	29	12.8	44.5	50	7	16	17	24	28	20	30	21	27	21	25	17	34	25	23	22	17	20	12	29	25	17	7	...	...
Averages				32.5	9	12	17	24	25	26	26	32	32	27	30	32	27	25	22	22	16	...	...	...	...	...	...	...	...
7	30	15	53	41	22	14	14	9	3	13	18	38	27	40	27	41	36	28	44	36	38	19	24	27	26	14	21	12	
8	30	13.5	47.5	39	22	20	24	35	18	15	14	18	24	31	18	22	23	36	29	12	15	24	31	24	22	17	16	20	
Average by 6-year periods.				6.3	...	...	...	...	...	18	...	...	...	...	...	27.6	...	...	...	...	...	26	...	...	...	...	...	...	

NOTE.—Trees Nos. 1 to 6 stood in shallow soil on gravel subsoil; Nos. 7 and 8 in deep loam.

From this table it appears that these eight trees grew on an average hardly more than 6 inches during the first six years, more than three times as fast during the next six years, and reached a maximum rate of over 27 inches per year during the third period of six years, the decline beginning after the twentieth year and the rate decreasing until it has fallen to about 15 inches near the thirtieth year.

To show how, under less favorable conditions, the progress of self-sown trees is very nearly the same, the following measurements may serve, from which it appears that natural seedlings on pastures, standing more or less crowded, reach at ten years a height of 10 feet; at the age of twenty years about 25 feet, and trees thirty-five to forty years of age, with diameters of 6 to 9 inches, attained and even passed the height of 60 feet, showing an average growth for that period of 15 to 18 inches per year:

TABLE II.—*Measurements of self-sown White Pine on pasture.*

[Furnished by Mr. J. E. Hobbs, of North Berwick, Me.; altitude, 250 feet.]

Number of tree.	Number of rings on stump cut at ground.	Number of rings 1 foot above ground.	Diameter of stump at ground.	Diameter 4 feet high.	Height of tree.	Length of leader at time of measurement.	Length of leader for last five years.
			Inches.	*Inches.*	*Ft. in.*	*Inches.*	*Ft. in.*
1	10	6	$2\frac{3}{4}$	$1\frac{1}{16}$	8 10	23	7 11
2	10	.....	$3\frac{1}{4}$	2	13 6	32	9 11
3	10	.....	$2\frac{5}{8}$	2	12 9	28	.....
4	10	8	$2\frac{5}{8}$	2	12 9	28	6 3
5	11	8	$3\frac{1}{4}$	$1\frac{3}{4}$	11 3	$29\frac{1}{2}$	8 5
6	12	9	5	$2\frac{5}{8}$	13 9	16	7 2
7	12	.....	4	3	.....	22	10 10
8	13	10	$5\frac{1}{2}$	$2\frac{1}{8}$	15 9	21	9 7
9	13	11	4	2	13 9	25	9 0
10	14	10	$3\frac{1}{2}$	2	13 9	24	8 0
11	14	.....	$4\frac{1}{2}$	3	16 6	21	.....
12	14	.....	$5\frac{1}{2}$	4	21 0	13	7 0
13	14	.....	$4\frac{1}{2}$	3	16 6	21	6 0
14	15	.....	$5\frac{1}{2}$	$4\frac{1}{4}$	25 0	18	.....
15	15	.....	$9\frac{1}{2}$	$4\frac{1}{2}$	20 6	18	.....
16	18	.....	$6\frac{1}{2}$	$5\frac{1}{2}$	28 4	33	.....
17	18	.....	$13\frac{1}{2}$	$10\frac{1}{4}$	.....	.....	.....
18	18	14	$5\frac{5}{8}$	$4\frac{1}{4}$	25 6	18	6 0
19	20	.....	$7\frac{5}{8}$	$4\frac{1}{8}$	25 6	30	6 6
20	22	16	$6\frac{1}{2}$	$5\frac{1}{2}$	28 10	33	7 0
21	26	22	5	4	29 9	14	6 1
22	36	.....	.....	$7\frac{1}{2}$	61 0	12	.....
23	38	.....	.....	$6\frac{3}{4}$	60 0	15	.....
24	39	.....	.....	9	64 0	15	.....
25	39	.....	.....	$6\frac{1}{2}$	60 0	18	.....
26	40	.....	.....	$9\frac{1}{4}$	60 0	18	.....

NOTES TO TABLE II.

No. 1. From old pasture after one year's tillage; 5 feet from No. 6; bore cones.

No. 2. With Nos. 1 and 3, and from similar trees.

No. 3. Old pasture, soil shallow, gravelly loam on compact subsoil of sand; pine mixed with Hemlock, Oak, and Maple.

No. 4. Level ground, soil heavy loam, somewhat shaded.

No. 5. From old pasture after one year's tillage; 5 feet from No. 6; bore cones.

No. 6. From old pasture after one year's tillage; 5 feet from No. 1; bore cones.

No. 7. From old pasture after one year's tillage; 5 feet from No. 6; bore cones; distant from neighbors 8, 34, and 19 inches.

No. 8. From old pasture after one year's tillage; 5 feet from No. 6; bore cones; touched another 4-inch diameter.

No. 9. Level ground, soil heavy loam, somewhat shaded.

No. 10. From old pasture after one year's tillage; 5 feet from No. 6, bore cones.

No. 11. Old pasture, soil shallow, gravelly loam on compact subsoil of sand; pine mixed with Hemlock, Oak, and Maple.

No. 12. On slight incline to north; soil nearly 3 inches from similar tree, with others quite near; crowded.

No. 13. Level ground, soil heavy loam, somewhat shaded.

Nos. 14–16. Old pasture, soil shallow, gravelly loam on compact subsoil of sand; pine mixed with Hemlock, Oak, and Maple.

No. 17. Isolated; lost leader six years previous, apparently through leader worm.

No. 18. Level ground, soil heavy loam, somewhat shaded.

No. 19. With No. 12; lost leader five years previous by leader worm; nearest neighbors 2, 5, and 10 feet, respectively.

No. 20. Level ground, soil heavy loam, somewhat shaded.

Nos. 21–26. Old pasture, soil shallow, gravelly loam on compact subsoil of sand; pine mixed with Hemlock, Oak, and Maple; ground slopes to west; all six trees, besides four others, within circle of 24 feet diameter; crown about 20 feet long.

Concerning trees 1, 2, 5, 6, 7, 8, and 10 (Table II), Mr. Hobbs sent the following interesting communication, under date of January 11, 1887:

All these trees were found in an old pasture adjoining my land on the north and having similar aspect and soil. A fringe of tall White Pine timber surrounds it on three sides, north, east, and south. The distance across this open land from north to south is about 60 rods. This land has been in pasture from fifty to one hundred years. It was formerly thickly covered with moss, sweet fern, and other low-growing bushes, in the shade of which animals found some grass. Although thus surrounded by tall pines their seeds seldom sprung up.

Not many years before these trees started a portion of this land was plowed and planted with potatoes one year, and then turned out to pasture again, whereupon young pines immediately sprung up. These were cut down first, but they continued to come up so abundantly that they were allowed to grow, and now the patch that was planted with potatoes is quite thickly covered, in many places too thickly, with trees like those measured. This fact shows the importance of turning up the soil so that the seeds that fall upon it may have a chance to take root. Only here and there a seed will find lodgment on land that is covered with moss and low-growing bushes, no matter how abundantly seeds may be sown upon it.

How such trees continue to grow is shown in Table III. From the measurements it appears that a steady growth continues, which, by the hundredth year has brought the tree to a height of near 100 feet.

TABLE III.—*Measurements of White Pine, grown on abandoned fields.*

[Furnished by Mr. J. E. Hobbs, of North Berwick, Me.]

Number of tree.	Age.	Diameter breast high.	Diameter below crown.	Length of crown.		Length of leader for last five years.	Total height.		Height at— 10 yrs.	20 yrs.	30 yrs.	40 yrs.	50 yrs.	60 yrs.	70 yrs.	80 yrs.	90 yrs.	100 yrs.	110 yrs.	120 yrs.
	Years.	*Inches.*	*Inches.*	*Ft.*	*In.*	*Inches.*	*Ft.*	*In.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	58	16	13½	50	0	66	80	10	15	28	42	55	69	.....	.....	.....	.....	.....	.....	.....
2	59	14½	10¾	30	0	69	67	6	10	20	31	45	57	.....	.....	.....	.....	.....	.....	.....
3	61	12½	7½	33	0	48	78	3	12	25	37	47	62	77	.....	.....	.....	.....	.....	.....
4	64	15½	10	28	6	56	70	2	11	24	36	47	58	68	.....	.....	.....	.....	.....	.....
5	70	15½	11¼	43	6	50	84	6	14½	30	46	60	68	76½	84½	.....	.....	.....	.....	.....
6	82	11½	8½	38	0	72	91	1	Only one log cut; height at fifty-eight years, 64 feet 10 inches.											
7	84	20¼	13	38	8	40	100	8	9	21	39	54	71	82	91	99	.....	.....	.....	.....
8	85	23	16¼	45	6	66	91	6	9	19	28	41	52	63	75	86	.....	.....	.....	.....
9	85	18	12½	39	4	62	92	7	8	16	26	39	52	64	76	87	.....	.....	.....	.....
10	87	25	18	49	10	36	104	10	8	16	28	47	66	77	87	97	.....	.....	.....	.....
11	87	19½	12½	40	4	72	100	2	9	21	35	48	60	70	81	93	.....	.....	.....	.....
12	108	32	21½	52	6	28	112	9	13	25	39	53	66	79	86	92	99	106	.....	.....
13	109	31	21	61	4	40	112	9	Not cut into sections.											
14	117	29	23	57	0	.....	101	10	14	27	40	48	55	62	69	76	83	90	97	.....
15	122	23	16	55	0	30	107	5	8	16	25	36	49	62	70	77	84	92	99	106½
16	123	28	19	50	0	24	97	4	10	21	35	52	58	63	69	74	80	85	90	96

NOTES TO TABLE III.

No. 1. North Berwick, Me.; near foot of hill sloping to north; growth, dense; apparently abandoned farm land; shallow, sandy soil.

No. 2. South Berwick, Me.; thrifty second growth, in valley of Great Works River; exhausted farm land on granitic formation; sand over 20 feet deep, well stocked with White Pine.

No. 3. North Berwick, Me.; near foot of hill sloping to north; growth, dense, apparently abandoned farm land; shallow, sandy soil.

No. 4. North Berwick, Me.; near foot of hill sloping to north; growth, dense; apparently abandoned farm land; shallow, sandy soil.

No. 5. South Berwick, Me.; thrifty second growth, in valley of Great Works River; exhausted farm land on granitic formation; sand over 20 feet deep, well stocked with White Pine.

Nos. 6–16. North Berwick, Me.; near foot of hill sloping to north; growth, dense; apparently abandoned farm land; shallow, sandy soil.

DEVELOPMENT IN THE FOREST.

In the dense forest the same general law of development, namely, of slow and rapid stages, prevails for dominant trees as is exemplified by the foregoing measurements of trees grown in the field, although the quantitative progress varies somewhat. According to the relative amount

of light at the disposal of the crown the rate of growth differs, and there is found, therefore, in the forest trees, though very nearly the same age, trees of different heights, according to the success of the struggle for light which they have had with their neighbors. At every stage of the development of a forest growth, after its juvenile period, the trees can be classified into dominant, the tallest, which grow with their entire crown in full enjoyment of light and space, overtopping their neighbors; codominant, which, although of same height, have their crowns narrowed in, but still unimpeded at the top; while others (oppressed) are pressed in from sides and top, and finally are entirely suppressed and die. This relationship of individuals changes from time to time, some of the codominant gradually falling into the class of oppressed, and of these a large number become suppressed. Occasionally a codominant becomes dominant, or an oppressed one, by liberation of its oppressors, through storms or accident, finds opportunity to push forward and make up for lost time. Thus, a natural growth may start with a hundred thousand seedlings per acre; by the twentieth year these will have been reduced by death to 6,000, and by the hundredth year hardly 300 may be left, the rest having succumbed under the shade of the survivors.

It is owing to these changes that in analyzing tree growth we find great, often unaccountable, variation in the rate of growth of even the same individual, and hence, in order to recognize the average, a very large number must be measured to even out the deviations from the law.

For the same reason it is desirable to classify the trees as indicated above and ascertain the rate of growth of trees grown under different light conditions. To be sure trees behave also somewhat differently under varying conditions of soil, climate, and exposure; hence, a further classification is necessary if it is desired to establish more than the mere general law of progress and also to ascertain the influence of these variable conditions.

In a general way, we find, as in the trees grown in the open, the slow seedling stage followed by a very rapid increase in the annual rate of growth, beginning with the sixth year and reaching a maximum of 16 inches with the tenth year in dominant trees. With trees which have not enjoyed access to light to the same extent the maximum occurs later; hence, in codominant trees it is reached, with 13 inches, in the twentieth year, while the oppressed trees reach their maximum current accretion still later, namely at forty years, with less than 12 inches for the year. As soon as this highest rate is reached decline takes place gradually in all classes, much faster in the dominant trees than in the less-favored ones, which decline in the rate of annual height growth much more slowly.

By the one hundreth year the annual height growth is reduced to from 6 to 7 inches, the dominant trees showing the lower rate, which continues to decline until about the one hundred and sixtieth to one hundred and seventieth year, when all tree classes have come to a rate of about 2 inches, at which they continue to grow, slowly but evenly, for another century.

This persistence of the height growth, which makes old trees tower 40 to 50 feet above their broad-leafed neighbors, influences also the shape of the crown, which does not flatten, as is the case with most pines. Very old trees, four hundred years and over, rarely exceed a height of 160 feet, although exceptional individuals have been found of the unusual height of 200 feet.

It will thus appear that the principal height growth is made during the first century, the second century noting a persistent but only slow progress.

If we take the average of all the yearly accretions at any one year of the life of the tree (the average annual accretion at that year), the influences which have been at work during the whole lifetime are of course reflected; therefore, since the juvenile period shows a slow growth, the average accretion attains its maximum much later. This culmination of the average annual accretion takes place much earlier in the more favored tree classes, namely, at about the twentieth to fortieth year, after that declining, while in the oppressed it does not occur until the seventieth year, maintaining itself afterwards for a long period.

This difference would also appear if we compared better and poorer sites. In other words, when the annual rate of growth is slow it remains more persistent than when it is rapid. The persistence noted in oppressed trees indicates also the shade endurance of the species. From Table IV, which gives the accretions from decade to decade (periodic accretion), we see the capacity of the species to thrive in spite of the shade, even in later stages of its life. Even after ninety years of oppression, when the tree is given opportunity by increase of light, it is still able

to make as good an annual height growth as its more-favored neighbors, and can continue the same to the second century. From the table of heights at various ages it is learned that the success in the juvenile stages after all tells on the total height growth.

TABLE IV.—*Periodic height growth, by decades, of dominant, codominant, and oppressed pine.*

Class.	Decades.																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
Dominant	8	12	13	13	11	10	8	7	6	6	5	5	4	3	3	3	3	3	3	3	3				
Codominant	4	12	10	10	12	6	8	8	7	6	5	5	4	4	3	3	2½	2½	2	2	2	2	2	2	1
Oppressed	4	8	7	8	9	9	8	8	6	6	6	5	5	4	4	4	3	3	3	2½					

Effect of composition of forest upon height growth.

The height development of White Pine seems to progress more rapidly when it grows mixed with other species. A striking instance showing how the height growth of White Pine is benefited by the presence of other species is given in the diagram (fig. 2), which represents the height growth of White Pine taken from two sites (*a* and *b*) in Presque Isle County, Mich. The sites were about 5 or 6 miles distant from each other. The soil and the moisture conditions on both sites were apparently identical (fresh sand), as were the total number of trees to the acre (the sample area on site *a* contained 181 trees and that on site *b* 189 trees) and the age of the trees and their distribution over the ground (density of crown cover). The only difference found between the sample areas staked off on both sites was the composition of the forest. Site *a* consisted of a mixed growth of Norway and White Pine, while site *b* represented practically a pure growth of White Pine save a few small Hemlock and an occasional Norway Pine. The diagram shows that the White Pine on site *a* was exceedingly stimulated in its height growth by the presence of the Norway Pine.

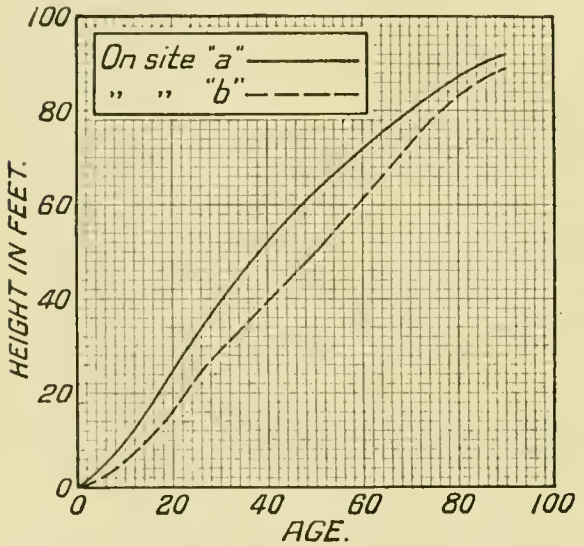


FIG. 2. Diagram showing height growth of White Pine in Presque Isle County, Mich.: Site *a*, in mixed growth; site *b*, in pure growth.

The associated species entering into the struggle for light with the White Pine naturally affect the progress of the height growth of the pine. The effects of the associated species upon the height growth of White Pine and the period of their influence depend upon the capacity of the associated species to grow in height as well as upon the time when the associated species are either introduced among the pine or received it under their shelter. In case, for instance, hardwoods accompany White Pine from the very start the influence of the hardwood upon the height growth of the pine will last only for the first sixty or seventy years, that is, up to the age at which most of the hardwoods practically reach their maximum height. In case the Norway Pine or the Hemlock starts simultaneously with the White Pine, the height growth of the White Pine will be stimulated to a considerably later age, because the Hemlock or Norway Pine continues to grow in height at a similar rate for a longer time. When the White Pine happens to start on ground already covered with other species in such a manner as not to be interfered with in its growth the associated species, if capable of growing in height to a later age, will stimulate the height growth of the White Pine for a considerably longer period. All this is clearly demonstrated in the accompanying diagram (fig. 3), representing the height growth of White Pine taken from three sites (*f*, *k*, and *i*) of identically the same conditions except as to composition of the forest and the difference in the ages between the pine and associated species. All three sites had a well-drained clayey loam underlaid by a laminated shale of indefinite depth. The White Pine on site *f* (Clearfield County, Pa.) was mixed with Hemlock of a large size; the pine on this site had started

among the Hemlock, which stimulated the height growth of the pine during all its lifetime. The White Pine on site *k* (Jefferson County, Pa.) was mixed with Hemlock of a small unmerchantable size. The pine here had started simultaneously with the Hemlock, which stimulated the height growth of the pine only for a certain period, after which the Hemlock, being overtopped by the pine, was out of the struggle and left in the capacity of an underwood. The White Pine on site *i*, which merged into site *k*, was mixed with hardwoods, which stimulated the height growth of the pine for the first sixty years, when the hardwoods reached their maximum height and then withdrew from the competition, leaving the pine to increase the height on its own account.

The influence of climate and soil on height growth will further appear from a study of the tables in the Appendix. This influence on height growth is not very great, if we confine our inquiry to regions of best development, the difference rarely exceeding from 5 to 10 per cent.

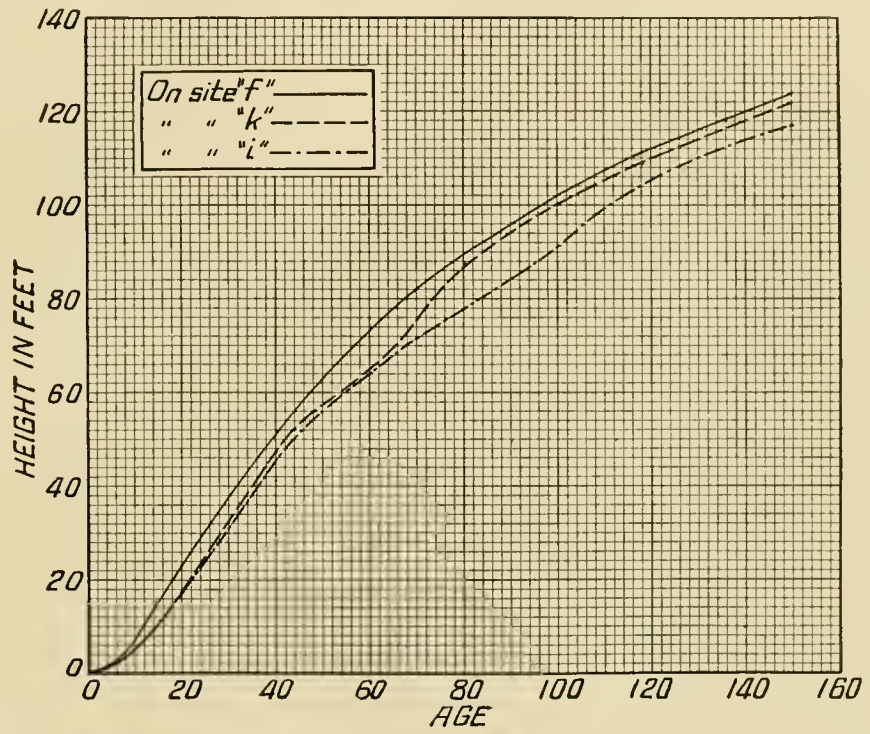


FIG. 3.—Diagram showing height growth of White Pine in forest of varying composition in Pennsylvania: Site *f*, Clearfield County; sites *k* and *i*, Jefferson County.

Effect of locality upon height growth.

Comparing the growth in different localities, it appears that the trees from Pennsylvania started at a lower rate than those in all other localities, but after the twentieth to the twenty-fifth year they surpass all others. If this can be accepted as correct, the deduction of the development in early youth from old trees being subject to errors, it may be explained by the fact that these trees grew in mixture with Hemlock and were kept back by the shade of their neighbors, but when they had outgrown these they felt the stimulus exerted by them.

The trees from Maine and Wisconsin, also starting more vigorously than those from Michigan, decline and sink below the Michigan trees between the eightieth and ninetieth year, which may for Wisconsin be possibly explained by the retarding influence of winds after the pines have outgrown the hardwoods, while in Maine the poorer soil may account for it. Michigan, with its tempered lake climate, presents a most regular and persistent height curve, coming nearest to the average of all locations.

In codominant and oppressed trees these differences do not come to an expression, but since the classification is somewhat doubtful and variations within wide ranges are possible, these data are hardly to be used for comparison as to locality effects.

GROWTH IN THICKNESS.

The growth in thickness, or diameter accretion, although remarkably regular in this species, is much more variable, but it is also more persistent, than the height growth, as will appear from the following comparisons: Thus, in five groups of trees from different sites, ninety-four to one hundred and nine years old, the heights differ only by a little over 8 per cent, varying from 91 to 98½ feet, while the diameters differed by almost 50 per cent, varying from 16 to 23.7 inches. Again the persistence is illustrated by the comparison of the height growth of five groups from two hundred and seven to two hundred and thirty-three years old, which showed an increase over the group just mentioned of somewhat over 20 per cent, while the diameters were by 30 per cent greater; and if the poorest groups of the two sets had been compared the difference would have been still more striking, namely, 15 per cent for the height as against 37 per cent for the diameters.

This is in part explained by the fact that, where the seedling springs up in the virgin forest, it is very apt to be suppressed for a longer or shorter period by the large mother trees and the host of deciduous and other forms which make up the forest cover. While the height growth is by this shade also impeded, this is not so to the same degree as the diameter, which is a direct function of the amount of foliage that is at work.

The sapling may thus remain a slender pole for many years, and not until it is able to lift its head above its crowding neighbors, or until light has been admitted to its branches, does it begin to expand its crown and consequently thicken its stem.

In managed forests, or in tracts where from any cause crowding has been prevented, the growth in diameter progresses somewhat more in the manner of the height growth, namely, slowly at first, then rapidly until the maximum is attained, when a slowly decreasing rate sets in. In the seedling the diameter growth is exceedingly small, very rapid in the young trees, when the annual ring is often one-sixth to one-half of an inch wide, but decreases with the slower rate of height growth. When the tree is sixty to eighty years old, the yearly ring is commonly not more than one-twelfth of an inch wide; it then gradually sinks to one fifteenth of an inch, which is then maintained throughout life, rarely falling to one twenty-fifth of an inch.

The average annual accretion reaches its maximum about the fiftieth to the sixtieth year with somewhat over one-fifth of an inch on the diameter of dominant trees, which rate is nearly maintained to the one hundred and fiftieth year.

Thrifty trees at forty years of age grown in the forest, measure from 6 to 9 inches in diameter breast high; at fifty years, from 10 to 12 inches; at eighty years, 15 to 17 inches; and they reach a diameter of 18 to 20 inches by the time they are a hundred years old.

To attain a diameter of 30 to 40 inches, which represents the best merchantable material of days now almost passed, more than two hundred years have been required, while trees four hundred to four hundred and fifty years old attain diameters of 50 to 60 inches and over. Trees of 40 inches diameter at three hundred years were by no means rare.

To be sure, there are exceptional individuals which exceed these dimensions, and variation in the rate of growth, due to soil, climate, and surrounding conditions, are naturally as frequent as in height growth.

The progress of diameter development of dominant, codominant, and oppressed tree classes, and in different localities, is exhibited in the tables and diagrams in the Appendix.

The usual method is to determine the diameters at 4½ feet from the ground (breast high), not only because when measuring standing trees the measurement is most conveniently made at this height, but because the lower diameters show much more irregularity. There is also more wood deposited near the base at and above the root collar, giving rise to the so-called root swelling (butt swelling), undoubtedly a provision to strengthen the stability of the tree. Unfortunately for the investigations here recorded, it was not practicable to have the trees cut and measured at breast height, since the measurements were made on trees felled in regular lumbering operations, exposing only the cross sections at the height of the stump, mostly 2½ feet above ground, and at log lengths. Even at that height (2½ feet above ground), a difference in the progress of diameter growth from that on higher cross sections is noticeable and becomes especially pronounced in later life, as is shown in the curves representing the progress of diameter growth on cross sections at various heights.

The diameters here given for the lowest section are, therefore, somewhat larger than those usually employed, namely, breast high, especially in later years.

The higher sections exhibit not only a regular course, but an entirely similar one, from cross section to cross section. There is no reason to assume that the course at breast height would not follow the same law; therefore there can be constructed a curve for this height similar to the curves of higher sections, using for guide points the data obtained from a series of measurements made to establish the yield of pine in which trees were measured at breast height (compiled in tables in the Appendix). This has been done on the diagram in the Appendix, which shows the diameter development of different cross sections for dominant trees. From this can be read the following average dimensions as approximating the diameters of each decade, leaving out the uncertain juvenile stage:

Diameter, breast high, of White Pine (averages approximated), in inches.

Decade.																		
20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
In. 4.5	*In.* 5.5	*In.* 8	*In.* 11.5	*In.* 13.5	*In.* 15	*In.* 16.5	*In.* 17.8	*In.* 19	*In.* 20.2	*In.* 21.3	*In.* 22.2	*In.* 23	*In.* 23.8	*In.* 24.5	*In.* 25.2	*In.* 26.4	*In.* 26.8	*In.* 27.5

That these figures may be considerably exceeded (even by 50 to 60 per cent) under favorable conditions will appear from the various tables of measurements in the Appendix. Especially is this the case in the second-growth groves of pine.

As will be readily seen in the curves after the juvenile stage, during which the diameter grows very slowly, an acceleration in the rate takes place, which soon reaches a maximum, continuing at that for a short time, and then slowly and persistently declining from about 3 inches per decade between forty and fifty years to 1¼ inches at one hundred years, and half that amount at two hundred years.

DETAIL MEASUREMENTS OF ANNUAL GAIN IN CIRCUMFERENCE.

An interesting set of most accurate observations have been made and reported by Mr. Nathaniel Morton, of Plymouth, Mass., exhibiting 38 young trees of White Pine, which had sprung up among oak and other hardwoods, mixed with White Pine and a few Pitch Pine in an old, rather-neglected piece of woods, and which were measured every year from 1891 up to 1898. The trees stand rather open. The age varied from twenty-eight to forty-two years, most trees being between thirty and thirty-six years old and their average age thirty-six years in 1891.

In 1891 the average cross section 3 feet from ground was 131 square inches; in 1898, 197 square inches; the growth 66 square inches, or about 9 square inches per year, one tree making 15 square inches per year. This growth corresponds to a growth in circumference of about 1.3 inches per year, or a growth in diameter of four-tenths of an inch per year.

The detail measurements are given in the following table:

TABLE V.—*Annual gain in circumference of White Pine trees in Massachusetts.*

Number of tree.	Circumference in 1890.	Gain, in quarter inches. 1891	1892	1893	1894	1895	1896	Total in six years.	Number of tree.	Circumference in 1890.	Gain, in quarter inches. 1891	1892	1893	1894	1895	1896	Total in six years.
	Inches.									*Inches.*							
1	55	3	5	5	5	4	5	27	27	31½	4	6	6	7	7	8	38
2	26	3	6	5	6	4	5	29	28	47	5	7	7	6	7	6	38
3	26	4	5	6	6	5	6	32	29	42	4	4	6	5	5	5	29
4	50	1	1	2	2	2	2	10	30	40½	4	5	6	5	5	5	30
5	28	1	3	4	3	1	3	15	31	57	0	2	5	5	4	4	20
6	38¾	0	1	3	3	2	1	10	32	44½	5	4	6	6	4	5	30
7	44	1	3	4	4	4	2	18	33	42½	1	5	5	4	5	5	25
8	27	2	3	4	5	4	5	23	34	44½	3	5	6	5	4	4	27
9	35	3	3	3	6	3	4	22	35	46½	4	4	6	4	5	5	28
10	40½	2	4	6	6	3	4	25	36	44½	3	3	4	4	3	3	20
11	34½	1	2	4	3	3	4	17	37	47	4	4	7	5	4	5	29
12	22	3	2	4	5	3	5	22	38	36½	2	4	6	3	4	4	23
13	44½	1	4	4	3	2	2	16									
14	33¾	4	4	7	5	5	4	29	Total		103	139	190	181	157	168	938
15	24½	4	4	5	7	4	4	28									
16	26½	5	5	6	6	5	4	31	Total in inches		25¾	34¾	47½	45¼	39¼	42	234½
17	28¼	1	3	3	4	3	3	17									
18	39	1	2	4	3	3	3	16	Percentage of gain as compared with gain of 1891		100	135	184	176	152	163	
19	48½	1	1	4	2	3	2	13									
20	50½	2	4	5	5	4	6	26									
21	49¾	5	6	7	6	7	8	39	Average gain per tree (in inches)		$\frac{66}{100}$	$\frac{91}{100}$	$\frac{125}{100}$	$\frac{118}{100}$	$\frac{103}{100}$	$\frac{111}{100}$	
22	49	4	2	3	6	5	4	24									
23	35½	3	4	5	6	6	5	29									
24	33	4	3	5	5	5	6	28									
25	51	2	3	6	5	5	7	28									
26	37½	3	3	6	5	5	5	27									

AREA ACCRETION.

While the diameter accretion decreases in rate continuously after the juvenile stage, the growth of the areas or layer of wood corresponding to the diameter increments follows by no means the same course.

After the juvenile stage, which is determined by the formation of a definite crown, and when the diameter has attained at least 6 inches the cross-section area begins to increase in arithmetical progression; a constantly increasing rate prevails until a maximum is attained, which comes between the sixtieth and one hundred and twentieth year, and then continues remarkably uniform for a long period. No decline is noticeable until after the second century has begun. In codominant and oppressed trees the area as well as the diameter accretion move somewhat differently, the maximum rate coming later and lasting a shorter time, the decline following soon after the maximum.

FORM DEVELOPMENT, OR TAPER.

Since size of crown and light conditions regulate the amount of diameter growth, it is evident that trees with well-developed free crowns form more wood than those crowded, the dominant more than the oppressed, and those on lawns more than those in the dense forest. Moreover, in these latter the wood is differently disposed along the trunk than in the former. Not only do trees grown in the open throw their energy into branch growth, but the accretion on the bole is laid on in layers, increasing in width from top to base. The result is a more rapid taper than in forest-grown trees, in which each annual layer is wider at the top than at the base of the tree, producing thereby a more cylindrical form.

The following table exhibits in the measurements of six trees this variation in the width of the same annual rings at different heights, and also in general the mode of diameter growth in these trees. More elaborate tables, showing the diameter growth of White Pine at various heights from the ground for dominant, codominant, and oppressed trees in various parts of its range, together with diagrams, will be found in the Appendix:

Diameter growth of forest-grown trees at various heights from ground.

Height of section from ground.	Width of rings, in millimeters.																		Age of tree.
	Single groups of ten rings, beginning at periphery.									Accumulative, by groups of ten rings, beginning at periphery.									
	1	2	3	4	5	6	7	8	9	10	20	30	40	50	60	70	80	90	100	
Feet.																				*Years.*
17	14	19	21	17	17	13	18	22	....	14	33	54	71	88	101	119	141	.....	.....	115
33	15	21	32	28	34	....	....	....	....	15	36	68	96	130	.....	.....	.....	.....	.....	
49	19	28	39	27	....	....	....	....	....	19	47	86	113	.....	.....	.....	.....	.....	.....	
68	27	58	....	....	....	....	....	....	....	27	85	....	.....	.....	.....	.....	.....	.....	.....	
16	9	10	16	20	21	40	39	....	....	9	19	35	55	76	116	155	.....	.....	.....	100
34	14	16	23	27	31	52	....	....	....	14	30	53	80	111	163	.....	.....	.....	.....	
50	16	22	25	37	40	....	....	....	....	16	38	63	100	140	.....	.....	.....	.....	.....	
66	19	19	32	....	....	....	....	....	....	19	38	70	.....	.....	.....	.....	.....	.....	.....	
18	11	13	16	15	15	20	32	48	....	11	24	40	55	70	90	122	170	.....	.....	105
34	12	15	18	20	22	36	50	....	....	12	27	45	65	87	123	173	.....	.....	.....	
50	13	17	23	31	39	39	....	....	....	13	30	53	84	123	162	.....	.....	.....	.....	
66	14	25	24	35	42	....	....	....	....	14	39	63	98	140	.....	.....	.....	.....	.....	
16	13	26	21	24	21	28	....	....	....	13	39	60	84	108	136	177	.....	.....	.....	102
28	20	24	28	31	39	....	....	....	....	20	44	72	103	142	170	.....	.....	.....	.....	
42	19	28	31	41	....	....	....	....	....	19	47	78	119	155	.....	.....	.....	.....	.....	
58	20	33	45	....	....	....	....	....	....	20	53	98	.....	.....	.....	.....	.....	.....	.....	
76	24	19	....	....	....	....	....	....	....	24	63	....	.....	.....	.....	.....	.....	.....	.....	
18	19	25	27	28	26	31	35	....	....	19	44	71	99	125	156	191	.....	.....	.....	110
34	23	33	35	44	31	....	....	....	....	23	56	91	135	166	.....	.....	.....	.....	.....	
50	24	34	34	40	....	....	....	....	....	24	58	92	132	.....	.....	.....	.....	.....	.....	
66	25	35	....	....	....	....	....	....	....	25	60	....	.....	.....	.....	.....	.....	.....	.....	
18	13	18	21	21	24	25	21	21	18	13	31	52	73	97	122	143	164	182	193	165
42	13	19	20	22	25	27	35	32	23	13	32	52	74	99	126	161	193	216	.....	
58	13	21	22	26	27	32	40	32	....	13	34	56	82	109	141	181	213	.....	.....	
70	16	25	25	32	35	....	....	....	....	16	41	66	98	133	.....	.....	.....	.....	.....	
86	11	29	29	....	....	....	....	....	....	11	40	69	.....	.....	.....	.....	.....	.....	.....	

From such tabulations the taper, factor of shape, or form factor, may be derived (see Tables II and V in Appendix), which denotes the deviation of the shape of the tree from a cylinder. This factor varies between 0.40 for the older trees and larger diameters to 0.50 for younger and

more slender trees, a factor of 0.45 being about the average for centenarians—that means the volume of a hundred-year-old tree is forty-five one-hundredths of a cylinder of the diameter, measured at breast height and the height of the tree.

This factor varies, of course, according to the ratio between diameter and height, and since in codominant and oppressed trees this ratio is a different one from that of dominant trees, as we have seen, their factor of shape is also different from that for dominant trees, that is, their taper differs, the former being more cylindrical than the latter. This will appear from a comparison of the taper of trees as recorded in Table 11 of the Appendix, in which small diameters with comparatively long shafts indicate the codominant and suppressed trees. Those with short lengths and large diameters are trees grown in open stand.

From Table 11, Appendix, we also see that the taper varies within wide limits from less than 1 inch to 5 inches for every 16 feet, although in the majority of cases it lies between 2 and 3 inches. The tops taper, to be sure, much faster than the middle portion; and, again, in older trees especially, the butt logs much faster than the upper portions, which are outside of the influence of the root swelling.

In young trees which make three log lengths of 16 feet, it will be safe to allow 1½ inches for the first two logs and 2 inches for the last one as the average taper. In medium-sized trees, making four to five log lengths, an allowance of 2 inches on the whole will fairly represent the average taper, or one-eighth of an inch for every foot in length. In old trees which furnish five and six or more logs, an allowance of 4 to 5 and even 7 to 8 inches must be made for the first log and 3 to 4 inches for the two top logs, while the middle portions show a more regular and less variable taper of about 2 inches, or one-eighth of an inch per foot.

GROWTH IN VOLUME.

During the juvenile stages the volume growth of the White Pine, as of most trees, is insignificant, a dominant tree of twenty years measuring not more than 0.5 cubic foot, which means an average accretion of 0.025 cubic foot per year. For the third decade the amount of wood formed is over three times what it was during the first two decades, and at fifty years the bole of a dominant tree may contain from 10 to 14 cubic feet and over, the average annual accretion having come up to one-fourth of a cubic foot, or ten times what it was at twenty years.

Now, after the rapid height-growth period, with fully developed crowns, a rapid rate of volume growth sets in, increasing with each year, in arithmetical progression, until at sixty to seventy years the current accretion has become 1 cubic foot and over, and at one hundred years as much as 1½ cubic feet is attained. After the one hundred and twenty-fifth year the increase in the rate abates, yet before the second century it has become 2 cubic feet, and remains then practically stationary for another century at least.

Some of the oldest trees (four hundred and fifty years and over) measured contained 600 to 800 cubic feet of wood in the stem alone, the largest, with 855 cubic feet, indicating an average annual accretion for this long life of over 1.8 cubic feet.

While the current annual accretion after the fiftieth year is rapidly increasing, the average annual accretion, affected by the earlier stages of slow growth, increases naturally more slowly. For the first one hundred years the average is about two-thirds to three-fourths of a cubic foot for dominant pine, making the volume about 70 cubic feet. It increases to 1 cubic foot at one hundred and fifty years and 1¼ cubic feet at two hundred years, and, as shown above, gains gradually until old age.

The progress in volume growth naturally varies under different soil conditions and with tree classes. In a general way, the oppressed trees and those on poorer sites do not begin the period of rapid volume growth as early as the dominant classes, but just as in the height growth, which is similarly delayed, the rate when once at its maximum persists with great uniformity until about the one hundred and fortieth to one hundred and sixtieth year, when a decrease becomes noticeable.

The tables and diagrams in the Appendix show, by figures and graphically, the progress of diameter, height, and volume accretion for dominant, codominant, and oppressed trees throughout the range of the species. Comparing the growth from the several localities represented, a striking

difference is not observed. It would appear that in similar soils the White Pine grows at about the same rate, with similar persistence, and to the same dimensions in all parts of its range.

In Europe, too, as appears from a table on page 69, its growth as well as its general behavior, at least in the forests of Germany, is fully as favorable as at home.

Besides differences as result of soils, an influence of the composition of the forest is noticeable. White Pine mixed with Hemlock (Pennsylvania stations) shows a more rapid growth for the first one hundred and thirty years, while among hardwoods (Wisconsin stations) the next one hundred years seem to produce the thriftiest growth. This is perhaps explained by the fact that in the latter mixture the White Pine has after the first one hundred years its entire crown above the shorter hardwoods, and hence is in full enjoyment of light.

The so-called "second growth" pine develops somewhat differently, because, as a rule, it does not start in a dense growth, enjoying the light conditions of the open stand, the single individuals make a more rapid volume growth, until they have closed up, and forest conditions prevail. This is fully exhibited in the measurements of young groves in Massachusetts and New Hampshire, tabulated in the Appendix.

In managed woods, where the number of trees allowed to grow per acre is under control, the volume accretion may also be accelerated; the growth energy of the site being then exerted on fewer individuals, each one deposits larger amounts. What this increase can be may be inferred from the table on page 69, which records the growth of White Pine in Germany.

CUBIC CONTENTS OF TREES.

Having ascertained by a large number of measurements the diameters, heights, and factors of shape possessed by trees under all sorts of conditions, the cubic contents of such trees can be calculated and recorded in a table for further use, by reference, in measuring contents of trees. Such table for White Pine of different diameters and heights will be found in the Appendix, from which the contents in cubic feet of the bole of a tree whose diameter at breast height has been measured and whose height has been estimated or measured can at once be read off.

LUMBER CONTENTS OF TREES.

The total cubic contents, being based on mathematical considerations alone, is the only rational measure of the volume. By stating contents in board measure we introduce at once a number of uncertain factors, which are variable in the practice, such as the lowest-size diameter to which logs are taken; the size of the lumber that is cut, from one-half-inch boards to square beams; the saw used, which determines the loss in kerf, and the skill of the sawyer, who can waste a large proportion in slabs and inconsiderate use of the logs.[1]

In these losses there is no allowance made for crooks or rot, which would reduce the results still further, so that hardly one-third of the total volume of the tree would seem to reappear in the shape of lumber, provided the log scales used are correct, which anticipate a loss of 44 per cent (Scribner) to 50 per cent (Doyle) in sawdust, slabs, and edgings for 14-inch logs, the average size of logs in the northern pineries.

As a matter of fact, in good modern mill practice, not only does no such waste occur as is indicated in these log scales, even if all logs were cut into inch boards, but in addition small logs are worked into dimension material 2 by 4, 2 by 6, 4 by 4, etc., in which the loss is reduced to a minimum; thus an 8-inch log may be cut to 6 by 6 inches. It then would make, if 16 feet long, not 16 to 25 feet B. M., but 48 feet. Since the bulk of our pine material is now obtained from small logs (over one half below 14 inches diameter), these differences are of considerable practical importance.

[1] A careful examination and measurement of one hundred trees of White Pine was made by Mr. Filibert Roth to ascertain what rational allowance should be made on the cubic contents of trees when converted into lumber. The average diameter of the trees measured was 28 inches, breast high with bark, and the height 100 feet, the factor of shape 0.43, that is to say, they were old trees with a moderate taper. They averaged 4.2 logs of 16 feet per tree, which represented 76 per cent of the total volume of the bole with bark, 24 per cent being lost in the top and stump and in the bark. The lumber contents of these logs, calculated by Scribner's log rule, represented only 39.5 per cent of the total volume of the tree, that is to say, over 60 per cent of the whole tree is supposed *not* to reappear in the lumber, the saw waste representing 48 per cent of the log volume and 36 per cent of the total volume of the tree.

Based upon a proper consideration of these practices, it will appear that an average allowance of 30 per cent in saw waste on the volume of logs of all sizes is more than ample, and that the lumber yield given in the following table and computed on this assumption of waste, although being for same sizes even 100 per cent above the log scales in use, remains still below the practically obtainable results:

Lumber contents in 16-foot logs.

Diameter at small end.	Judson's favorite.	Doyle rule.	Scribner rule.	Computed for 30 per cent waste.	Waste.	
					By Scribner.	By Doyle.
Inches.	*Feet B. M.*	*Feet B. M.*	*Feet B. M.*	*Feet B. M.*	*Per cent.*	*Per cent.*
8	22	16	25	32 to 48 46	61	76
10	37	36	49	60 to 85 72	50	65
12	64	64	79	100 to 130 105	47	57
14	95	100	114	142	44	51
16	142	144	159	187	41	46
18	197	196	213	237	37	42
20	248	256	280	292	33	39
22	324	324	334	336	34	36
24	392	400	404	420	33	33
26	476	484	500	492	30	32
28	562	576	582	564	29	30

In estimating the cut of lumber that may be obtained from a given area, there must, to be sure, an allowance be made in addition for unserviceable, crooked, knotty, rotten material, which may reach from 15 to 20 per cent, and, furthermore, an allowance for the loggers' risk in breakages and other losses, which may be figured at 10 to 12 per cent.

To give, however, an approximate idea of the lumber contents of trees of various diameters and heights, these have been calculated for a number of trees and recorded in Table II, p. 87, in the Appendix.

From these measurements, which are based upon Doyle's log scale, the following tabulation is made, showing approximately the increase of lumber contents with diameter growth and age. From this it would appear that the greatest per cent of increase occurs during the period from the fortieth to seventieth year, while in the fortieth year the average annual growth in volume has been about one-third of a cubic foot, in the seventieth year it is nearly 2 cubic feet, or six times as great, and by the one hundredth year this rate is doubled, centenarians containing about 400 feet B. M. During the next century the trees make twice as much lumber wood, for now all wood deposited makes lumber:

Increase in lumber contents with size.

Diameter breast high.	Height.	Approximate age.	Lumber.	Average annual accretion.	Periodic accretion.	Per cent of increase per year during preceding period.
Inches.	*Feet.*	*Years.*	*Feet B. M.*	*Cubic feet.*	*Feet B. M.*	*Per cent.*
7 to 9	50 to 70	40	14	0.35	.....	.....
10 to 12	50 to 80	55	50	.9	36	17
13 to 15	55 to 115	70	130	1.8	80	17
16 to 18	75 to 125	85	260	3	130	7
19 to 21	80 to 135	110	440	4	180	3
22 to 24	85 to 140	140	650	4.6	210	1.7
25 to 27	85 to 150	185	940	5.1	290	1
28 to 30	85 to 150	230	1,200	5	260	.6

CONDITIONS OF DEVELOPMENT.

DEMANDS UPON CLIMATE AND SOIL.

The wide field of its natural distribution and the thriftiness with which the White Pine develops in climates outside of its native home show that it is quite adaptive as far as climatic conditions are concerned. Yet, from the manner of its development within the climatic range of its

occurrence, its use for forestal purposes would seem to be circumscribed by conditions of humid and cool atmospheres, such as are found in northern latitudes and high altitudes. Its distribution is manifestly more dependent on humidity than on temperature, or rather, on a low transpiration factor, that is, such a relation of heat and moisture, both at the foot and at the top, that the thin foliage can readily perform its functions; hence, its failure in cultivation in the trans-Missouri States, the contraction of its southern field to the high altitudes, and its best development in quantity if not in quality within the influence of the Great Lakes and to the northward and eastward.

While adapting itself readily to almost any variety of soil, the White Pine manifestly prefers one with a fair admixture of sand, insuring a moderately rapid drainage. The pine tribe in general occupies the sandy soils, to which it is better adapted than most of the deciduous tree species; but the White Pine is capable of disputing possession with its competitors even of the fresh medium-heavy loam and clay soils, making here the best individual growth.

Its shallow root system, in which it resembles, as in many other respects, the spruces, permits it to accompany the latter to the thinner soils of the rocky slopes in the Adirondacks and New England States, although here its development is naturally less thrifty. Its growth on the rocky hills of Massachusetts within the hardwoods of that region is, however, at least for the first sixty to eighty years not much less thrifty than in the better soils in the valleys. It does not shun even the wetter and occasionally overflowed and swampy ground, and is here found, together with the Fir, Arborvitæ, and even Tamarack; yet, on the dry, light sandy, coarse, and gravelly soil the Red Pine and Jack Pine seem to be able to outdo it.

ASSOCIATED SPECIES.

The White Pine is less gregarious than any other pines of the Eastern United States. Although it occurs in pure growths as true pinery on the red clays and moister gravels, it more frequently is an admixture in the hardwoods, sharing with them the compacter, heavier soils from which the other pines are excluded.

Spruce, Hemlock, and Arborvitæ (Cedar) are most frequent concomitants of the White Pine in Canada; various species of Birch and Maple with Beech and Spruce form the composition of the forest in the Adirondacks, overtowered by the pines, and there is hardly any species of the Northern Atlantic forest which in one or the other region of its distribution may not be found in association with the White Pine.

Owing to the fact that the hardwoods as a rule occupy the better soils, the best individual development of the White Pine is also found in these mixtures. In the pinery of the northwest Red Pine and Jack Pine are the associates, while the Pitch Pine (*P. rigida*), and, in the southern field, the Shortleaf Pine (*P. echinata*) are not unfrequently found in its company.

The samples of "acre yields" following will serve to illustrate more in detail the manner of distribution, the associations, and the capacity of White Pine in the native forests in different parts of its range. More extensive tabulation will be found in the Appendix.

TABLE VI.—*Acre yield of White Pine on sites in Wisconsin, Michigan, Pennsylvania, and Maine.*

WISCONSIN.

SITE *a*: Washburn County.

Description of site.	White Pine.					Basswood.			Fir.			Elm.			Yellow Birch.			Butternut.			Hornbeam.		
	Number of trees.	Diameter (breast high).	Height.	Volume.		Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
				Boles.	Merchantable timber.																		
		In.	*Ft.*	*Cu ft.*	*Ft. B. M.*		*In.*	*Ft.*		*In.*	*Ft.*		*In.*	*Ft.*		*In.*	*Ft.*		*In.*	*Ft.*		*In.*	*Ft.*
Sample area, 1 acre, 1,200 feet above sea. Age of pine, 200 to 220 years. Number of trees, 132: White Pine, 52 per cent; hardwoods 48 per cent. Classification for White Pine: Dominant, 75 per cent; oppressed, 22 per cent; suppressed, 3 per cent. Two-story stand, upper story formed by White Pine, the lower story by hardwoods (Yellow Birch mixed with Basswood with scattering Hornbeam and Fir and occasional Elm). Scanty undergrowth of the young hardwoods and Fir. Soil, clay, underlaid by a hardpan of clay and stones, 4-inch mold on top, with a surface cover of leaves.	1	14	80 to 120.	55	.....	9	3 to 6	40	5	3 to 6	40	1	3 to 6	40	12	3 to 10	40	1	3 to 6	40	5	3 to 6	40
	1	16		71	.....	6	6 to 10	60	...	.....	...	...	.....	...	16	6 to 10	60	1	6 to 10	60	1	6 to 10	60
	3	19		288	.....	...	.....	...	...	.....	...	...	.....	...	2	10 to 14	80	...	.....	...	...	.....	...
	2	20		210	.....	...	.....	...	...	.....	...	...	.....	...	3	14 to 18	80	...	.....	...	...	.....	...
	1	21		114	.....	...	.....	...	...	.....	...	...	.....	...	1	19	80	...	.....	...	...	.....	...
	2	22		280	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	6	23		918	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	9	24		1,440	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	3	25		534	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	6	26		1,152	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	5	27		1,035	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	5	28		1,155	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	6	29		1,482	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	3	30	120 to 140.	780	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	2	31		560	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	1	33		315	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	1	34		347	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	3	35		1,101	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	3	36		1,161	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	1	37		408	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	1	38		429	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	1	39		485	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	3	40		1,521	.....	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...	...	.....	...
	69	.....	.....	15,841	95,040	15	.....	...	5	.....	...	1	.....	...	34	.....	...	2	.....	...	6	.....	...

Average annual accretion: White Pine, 75 cubic feet.
452 feet B. M.

MICHIGAN.

SITE *d*: Montmorency County.

Description of site.	White Pine.					Red Pine.			Hemlock.		
	Number of trees.	Diameter (breast high).	Height.	Volume.		Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
				Boles.	Merchantable timber.						
		Inches.	*Feet.*	*Cu. ft.*	*Ft. B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
Sample area, 1 acre. Age of pine, 250 to 270 years. Number of trees, 113: White Pine, 54 per cent; Red Pine, 35 per cent; Hemlock, 11 per cent. Locality damaged by fire twelve years before; 15 per cent dead trees and 20 per cent injured by fire. White Pine mixed with Red Pine and intermixed with Hemlock. Soil, fresh, loose sand of a gray color, turning brown and red underneath, with a surface cover of brakes, checkerberry. The subsoil is a brown sand, sometimes loamy and in spots clayey. Density of crown cover, 0.5.	2	10	120 to 140.	36	.....	2	13	120 to 140.	2	3 to 6	40
	1	12		38	.....	1	14		1	9	
	3	13		159	.....	3	15		1	11	
	1	14		60	.....	1	16		2	12	50 to 80
	3	15		207	.....	3	17		6	15	
	3	16		231	.....	3	18		1	20	
	1	17		86	.....	6	19		.....	.....	.....
	1	18		96	.....	5	20		.....	.....	.....
	3	19		315	.....	4	21		.....	.....	.....
	2	21		280	.....	8	22		.....	.....	.....
	6	22		906	.....	1	23		.....	.....	.....
	5	23		855	.....	1	24		.....	.....	.....
	9	24		1,611	.....	1	30		.....	.....	.....
	4	25		800	.....	.....	.....		.....	.....	.....
	1	26		216	.....	.....	.....		.....	.....	.....
	3	27		696	.....	.....	.....		.....	.....	.....
	2	28		498	.....	.....	.....		.....	.....	.....
	7	29		1,862	.....	.....	.....		.....	.....	.....
	2	30		560	.....	.....	.....		.....	.....	.....
	1	31		302	.....	.....	.....		.....	.....	.....
	1	33		340	.....	.....	.....		.....	.....	.....
	61	.....	.....	10,154	60,900	39	.....	.....	13	.....	.....

Total yield: 86,100 feet B. M., of which White Pine 66 per cent.
Volume of Red Pine: Boles, 5,256 cubic feet; merchantable timber, 25,200 feet B. M.
Average annual accretion: White Pine, 59 cubic feet.
331 feet B. M.

TABLE VI.—*Acre yield of White Pine on sites in Wisconsin, Michigan, Pennsylvania, and Maine*—Continued.

PENNSYLVANIA.

SITE *f*: Dubois, Clearfield County.

Description of site.	White Pine. Number of trees.	Diameter (breast high).	Height.	Volume. Boles.	Volume. Merchantable timber.
		In.	*Feet.*	*Cu. ft.*	*Ft. B. M.*
Sample area, 1 acre, 1,200 to 1,500 feet above sea. Age of pine, 240 to 260 years. Number of trees, 132: White Pine, 37; Hemlock, 84; Maple, 5; Beech, 3; Birch, 3. Hemlock mixed with White Pine, with occasional Maple, Beech, and Birch, on a hill sloping towards southwest, where it is bounded by the left hand branch of the Narrow Creek. The undergrowth, moderately dense, consists of very young Beech, Hemlock, and occasional Birch and Cucumber. Soil, yellow clayey loam of a medium grain (fine shales in it), deep, fresh, well drained, with 2 to 3 inches mold on top, with surface cover of scanty leaves, fern, teaberries, and scattering dogwood (laurel, northeast corner and north side). Subsoil, laminated shale of an indefinite depth. Density of crown cover, 0.7 (in places 0.8).	2	15	120	360	1,360
	2	17	120		
	2	18	130		
	1	19	130		
	1	20	130	1,370	6,420
	4	21	130		
	2	22	130		
	2	23	130		
	1	24	130	570	3,000
	3	25	135	651	3,690
	1	26	135	257	1,390
	2	27	135		
	1	28	135	1,140	6,600
	1	29	135		
	2	30	145	610	3,900
	4	31	145	1,220	7,800
	1	32	145	390	2,300
	2	34	145	800	4,800
	1	40	145	511	3,300
	1	41	145	511	3,300
	1	45	145	638	4,400
	37	.....	.....	9,028	52,260

Total yield: 90,103 feet B. M.
Average annual accretion: White pine, 36 cubic feet.
209 feet B. M.

MAINE.

SITE *a*: York County.

Description of site.	White Pine. Number of trees.	Diameter (breast high).	Height.	Volume of bole.
		In.	*Feet.*	*Cu. ft.*
Sample area, one-half acre. Age of pine, 90 to 100 years. Number of trees: White Pine, 118; Red Oak, 6; Norway Pine, 2. Classification for White Pine: Dominant, 26 per cent; codominant, 40 per cent; oppressed, 18 per cent; suppressed, 16 per cent. White Pine with scattering Red and White Oak and occasional Norway Pine, on a level site. The undergrowth, moderately dense, consists of small Hemlock and Beech, small Maple and Oaks numerous. Soil, a fine loamy sand, gray or brown in color, deep, fresh, with 2 or 3 inches mold on top, and leafy surface cover; clay lies probably some feet below surface. Density of crown cover, 0.5.	2	10	75	42
	8	11	75	192
	8	12	75	233
	4	12	85	120
	6	13	85	222
	4	14	75	154
	8	14	85	332
	8	15	85	384
	8	16	85	408
	8	17	85	528
	10	18	85	690
	18	19	85	1,323
	2	20	85	152
	4	21	85	320
	6	22	85	534
	6	23	85	660
	2	24	95	250
	2	25	95	280
	4	26	95	560
	118	.....	.....	7,384

Average annual accretion: White Pine, 77 cubic feet.
Current accretion: White Pine, 160 cubic feet.

MAINE.

SITE *b*: York County.

Description of site.	White Pine. Number of trees.	Diameter (breast high).	Height.	Volume of bole.
		In.	*Feet.*	*Cu. ft.*
Sample area, one fourth acre. Age of pine, 50 to 60 years. Number of trees: Mature White Pine, 328; young White Pine, 160; mature Hemlock, 20; young Hemlock, 20. Classification for White Pine: Dominant, 9 per cent; codominant, 45 per cent; oppressed, 23 per cent; suppressed, 23 per cent. White Pine, with scattering Hemlock and occasional Spruce and Fir, on a plain and level site. Scanty undergrowth of Hazel and young Hemlock. Soil, a gray sand, sometimes brown or loamy, with a vegetable mold of 3 inches, deep, fresh, with a leafy surface cover. Clayey subsoil, probably 4 or 5 feet below surface. Density of crown cover, 0.7.	4	6	45	20
	32	7	55	256
	60	7	45	330
	84	8	55	840
	8	8	45	72
	36	9	55	414
	8	10	65	144
	52	10	55	780
	8	11	55	144
	12	12	65	306
	12	12	55	240
	4	13	65	116
	8	17	75	408
	328	.....	.....	4,070

Average annual accretion: White Pine, 74 cubic feet.
Current accretion: White Pine, 133 cubic feet.

MAINE.

SITE *c*: York County.

Description of site.	White Pine. Number of trees.	Diameter (breast high).	Height.	Volume of bole.
		In.	*Feet.*	*Cu. ft.*
Sample area, one-fourth acre. Age of pine, 50 to 60 years. Number of trees: Mature White Pine, 396. Classification for White Pine: Dominant, 18 per cent; codominant, 27 per cent; oppressed, 24 per cent; suppressed, 31 per cent. White Pine, with occasional Norway Pine, on a slope to north 5° to 10°. Scanty undergrowth of Hemlock, Oak, and Fir. Soil, a sandy loam, with little pebbles in it, of a brown color, deep and fresh, with black soil and mold of 3 inches on top and leafy surface cover; clay probably 8 to 12 feet down. Density of crown cover, 0.8.	4	6	65	28
	28	6	55	168
	20	7	65	190
	20	7	55	160
	84	8	65	1,008
	24	8	55	240
	36	9	65	522
	32	10	65	576
	8	10	75	168
	40	11	65	880
	4	11	75	100
	16	12	65	408
	24	12	75	696
	8	13	65	232
	16	13	75	552
	4	14	65	132
	12	14	75	462
	8	15	65	292
	4	16	75	184
	4	17	75	204
	396	.....	.....	7,202

Average annual accretion: White Pine, 131 cubic feet.

LIGHT REQUIREMENTS.

The capacity of the White Pine to keep its place in mixture with the hardwoods is probably mainly due to its shade endurance. In this respect it excels all pines with which we are acquainted. Pines are, as a rule, rather light-needing species, and are usually at a disadvantage in the mixed forest, unless compensating influences are in their favor. The White Pine is an exception. As a consequence, it is capable of forming dense thickets, supporting a larger number of trees per acre and producing a larger amount of material than the more light-needing species. Also, as a consequence of its shade endurance, it does not clean itself of its branches as readily as other pines; not only do the lower branches remain green for a long period in spite of the shade of the superior tiers of foliage, but they persist after they are dead for many years.

As this shade endurance is, however, only relative, and as many of the associates possess it in greater degree, the additional advantage of rapid height growth alone saves the pine from being after all suppressed by its shadier companions. Yet, these succeed in keeping the young progeny of the pine subdued, and hence the observation that in the dense virgin forest of hardwoods the reproduction of White Pine is scanty.

The difficulty of cleaning itself of dead branches seems to be overcome by association with shadier companions, for, as a rule, the best quality, cleaner boles, and absence of black knots, which denotes earlier cleaning, are found in such association. Yet, in these mixtures the trees are apt to be shorter bodied, since the hardwood companions are shorter bodied and the stimulus to height growth ceases sooner. In the pinery proper the stimulus to height growth exerted by the neighbors continues longer; hence, longer shafts are found here, other conditions being the same, although the boles are less clean and less free of knots.

Its shade endurance is decidedly less than that of the Spruce, which maintains itself, but not thriving under the dense shade of Maple, Birch, and Beech, where White Pine seedlings and saplings are not to be found, although they sustain perfectly the shade of oaks. To be sure, this shade endurance is to some extent dependent on moisture conditions of soil, being less on the drier than on the fresher soils.

This relatively high shade endurance permits ready natural reproduction of the pine, especially where the hardwoods have been thinned out to some extent, or where, after clearing, all species start their race for reoccupation of the soil with equal chance. The pine then appears in the young hardwood growth in single individuals at first, somewhat behind in height, but finally, when it enters upon the period of rapid height growth, it outgrows its competitors and is assured of its place.

More frequently does the reproduction take place in groups, smaller or larger, the many areas of "second growth" of several acres in extent, which are found throughout the hardwood coppice of Massachusetts, showing that tendency toward gregariousness so characteristic of the conifers. A further discussion of the conditions of reproduction and the yield occurs in the portion devoted to the discussion of forest management and of forest yield.

In these natural reproductions the trees grow close together, that is, close for unaided natural reproduction, as is apparent from the following table of acre yields of young growth taken at various places in New England:

TABLE VII.—*Acre yield of young pine groves.*

State.	Soil.	White Pine.						Species intermixed.	
		Age.	Number.	Diameter (breast high).	Length of log.		Volume of logs.	Number.	Name and remarks.
					Max.	Min.			
		Years.		*Inches.*			*Cu. feet.*		
Massachusetts	Fresh, well-drained loam and sandy loam.	35	2	14 to 18	40	35	54	147	Oak.
			128	10 to 14	40	20	1,611.2	52	Chestnut.
			284	6 to 10	35	20	348.9	21	Maple.
			75	3 to 6				8	All other.
			1	3					
Total			490				2,014.1	228	All small.
New Hampshire	Dry, well drained sandy loam.	35	3	18 to 24	30	18	178.9	13	Maple.
			13	14 to 18	30	22	372.4	10	Gray Birch.
			79	10 to 14	35	15	1,007	9	Pitch Pine.
			231	6 to 10				6	All other.
			181	3 to 6					
			5	3					
Total			512				1,558.3	38	

TABLE VII.—*Acre yield of young pine groves*—Continued.

State.	Soil.	White Pine.						Species intermixed.	
		Age.	Number.	Diameter (breast high).	Length of log.		Volume of logs.	Number.	Name and remarks.
		Years.		*Inches.*	*Max.*	*Min.*	*Cu. feet.*		
Massachusetts	Fresh, well-drained sandy loam.	40	14	14 to 18	40	25	315.9	133	Oak.
			136	10 to 14	40	20	1,870.4	204	Maple.
			177	6 to 10	.....	.....	.....	19	Chestnut.
			32	3 to 6	.....	.....	.....	15	Gray Birch.
			3	3	.....	.....	.....	11	Cherry.
			.....	.....	.....	.....	.....	15	All other.
Total	.....	.....	362	.....	.....	.....	2,186.3	397	All less than 3-inch diameter.
New Hampshire	Dry, well-drained loamy sand.	40	46	14 to 18	35	15	489.3	26	Hemlock.
			65	10 to 14	30	15	51.9	27	Red Pine.
			184	6 to 10	.....	.....	.....	1	Gray Birch.
			615	3 to 6	.....	.....	.....	.....	
			150	3	.....	.....	.....	.....	
Total	.....	.....	1,060	.....	.....	.....	541.2	54	Small.
Massachusetts	Fresh, well-drained sandy loam.	48	11	14 to 18	40	30	258.2	.....	None.
			158	10 to 14	40	15	2,096.9	.....	
			277	6 to 10	.....	.....	.....	.....	
			18	3 to 6	.....	.....	.....	.....	
Total	.....	.....	464	.....	.....	.....	2,355.1	.....	
Massachusetts	Dry, well-drained loamy sand.	50 to 55	1	18 to 24	35	.....	102	19	Representing seven species.
			48	14 to 18	40	20	902	.....	
			126	10 to 14	40	15	1,311.5	.....	
			147	6 to 10	30	18	152.2	.....	
			15	3 to 6	.....	.....	.....	.....	
Total	.....	.....	337	.....	.....	.....	2,467.7	19	

It would be possible to increase the number of trees that could grow per acre and develop satisfactorily by attention of the forester, as will appear from the statements regarding the White Pine forest plantations in Germany, where pure White Pine growths showed at sixty-eight years still over six hundred and seventy trees, and in another place at eighty-two years seven hundred and twenty-three trees, and at one hundred and four years over two hundred and fifty trees per acre. Even in such close stand the crown of living branches remains long, occupying one-third of the bole, and dry branches persist down to over half the length. The stems are straight and cylindrical, in this respect also reminding one of the Norway Spruce, although the tendency to fork seems more frequently developed.

YIELD OF WHITE PINE.

The question as to the amount of material which the White Pine is capable of producing per acre is difficult to answer. It can not, of course, be deduced from a knowledge of the development of the individual tree, since there remains one factor unknown, namely, the number of trees of different classes that can occupy an acre. Nor can the capacity of production, as a rule, be ascertained from the actual production or acre yield of natural virgin growths, for these usually not only do not occur in pure growths, but also are usually not developed under most advantageous conditions, and do not, therefore, represent the possible or normal yield which could be secured. Only by selecting smaller, seemingly normally and favorably developed groups in the forest at different ages and in various localities and measuring the same may we arrive at an approximation of what the species is capable of producing by itself.

Such measurements have not been attempted, but the yield of virgin acres under varying conditions has been ascertained to give at least a forecast of the possibilities, although not representing the normal or possible yield of fully stocked acres of White Pine. In addition we may utilize the results recorded from Germany (page 69) of a number of plantations, which have had the advantage of at least the partial care of forest management.

From these indications, we are justified in the assertion that the White Pine produces per acre as well as any species with which we are acquainted in our northeastern woods, and at a rate which is not excelled by any of the lumber trees within its range.

In this respect, again, it approaches the German Spruce, though it probably excels this species in persistency, as it does in the dimensions which it can produce. We can, therefore, for the first

hundred years at least, approximate the capacity of our White Pine by reference to experience tables of the German Spruce.

As with all conifers, the rate of production at first is very slow, not more than 40 to 70 cubic feet in the average per year for the first twenty years. With the better development of crowns and the assertion of individual superiority in the struggle of neighbors, which leads to the establishment of dominant classes, the production increases rapidly, and by the fiftieth year, in fully stocked areas, the average rate of 140 to 160 cubic feet per acre may be attained, so that at that age we may, with five hundred to six hundred trees to the acre, find 7,000 to 8,000 cubic feet of wood stored up in the boles of the trees. The current annual accretion, then, may readily be at the rate of 160 to 180 cubic feet, keeping the average annual accretion of fully stocked acres very nearly to those figures, so that at one hundred years we should find, under favorable conditions, as much as 15,000 cubic feet of wood, of which at least 80,000 to 90,000 feet B. M. is saw material.

The persistency of growth seems to continue beyond that age, and the indications are that the decrease of the current as well as average accretion per acre during the next century takes place so gradually that at one hundred and fifty years it may still be over 100 cubic feet, and not much below at two hundred years, when the burden of the acre may be near 20,000 cubic feet, with over 120,000 feet B. M., and double the amount in the oldest growths of two hundred and fifty or more years, which may possibly be the limit of production.

While these figures, which differ very materially from those proposed in the tables by Messrs. Pinchot and Graves, may stand for the better soils, as ideally possible, practically, perhaps, rarely attainable, especially in older stands, poorer soil sites will vary from them by from 20 to 40 per cent, so that a yield of 9,000 cubic feet at a hundred years, or 50,000 feet of lumber, would still be quite reasonable to expect on the poorest soils on which White Pine can be satisfactorily grown. On the sandy soils of Wisconsin whole forties are found to average 50,000 feet per acre of naturally grown unattended forests of one hundred and fifty years of age.

Table VIII summarizes the measurements of sample areas, which are given in detail in the Appendix. It will serve to show what our native woods, without attention, stocked with partly useless trees and in open stand, exhibiting much wastage in unoccupied ground, are capable of producing.

If we assume that the areas might have been stocked with pine alone, that they would have produced at only the same rate as they have under their present conditions, even though the acres had been fully stocked and not in the fractional manner which is indicated by the decimal giving density of cover (all assumptions), and if in connection with the density factor we consider the number of all trees per acre and the percentage which the pine represents, we may, as a mere matter of judgment not fit for tabulation, arrive at an indication as to what the acre might possibly have produced. Such indication of possibility has been attempted in the last column of the table, and has served in the above discussion in connection with all other data presented. This is all that can be done in the absence of the measurements above indicated. These figures are of no direct practical application except to give a general notion of the productivity of White Pine and the variability of yields.

An inspection of the table of yield in Germany, on page 69, will show that these approximations are not unreasonable. The lumber contents in board feet may be approximated by multiplying these figures by 4 or 5 in the younger growths and by 6 or 7 in the older. Assuming a moderately careful practice of logger and sawyer, by no means mathematically tenable, the above tentative propositions for normal yields might be even increased.

To assume, as is done by certain authorities, that tables of normal yield could be constructed by using the density indicated by a decimal as a mathematical factor, using that factor as a divisor of the actually measured yield in order to arrive at the normal, is to mistake the value of the density factor. Not only would trees and whole acres have developed very differently when grown under different density conditions during their life, but the estimate of the density is such a vague and uncertain one, a mere opinion, that even if the greatest care were exercised, its use as a mathematical factor would not be admissible. It is a mere indication of the present condition of the growth, and its meaning at different periods of life is very different in its physiological effects as expressed in volume accretion.

TABLE VIII.—*Acre yield of White Pine in natural forest.*

[Condensed from fuller tables of measurements in Appendix. Where admixtures are reported as scattered for brevity's sake 1 per cent has been allowed.]

State.	Site.	Age.	Character of—		Number of trees.		Density.	Volume.					Indication of possibility
			Soil.	Forest.	All.	White Pine.		All species.		White Pine.			
								Cubic feet.	Feet B. M.	Cubic feet.	Feet B. M.	Per cent of total yield.	
		Years.		*Per ct.*									*Cubic feet.*
Massachusetts	*f.*	25 (cultivated.)	Sandy loam	White Pine 73 Hardwood 23 Pitch Pine 4	*a* 779	*a* 560	(?)			1,536			2,000
Pennsylvania	*g.*	25 to 35	Clay loam	White Pine 71 Hardwood 29	*b* 183 *a b* 1,301	*a* 131 *a b* 154	0.5 to 0.6			1,152			3,000
Massachusetts	*h.*	30 to 35	Sandy loam	White Pine 99 Hardwood 1		*a* 301 90	Full.			4,520			4,600
Massachusetts	*i.*	35	Sandy loam	White Pine 99 Hardwood 1		*a* 413 77	0.8			5,540			6,000
Massachusetts	*j.*	35 to 40	Black loam	White Pine 99 Hardwood 1		*a* 313 89	0.8			3,973	*a* 16,000		5,000
New Hampshire	*o.*	35 to 40	Loam	White Pine 99 Red Pine 1		*a* 435	0.8			5,649	*a* 22,500		6,000
New Hampshire	*p.*	35 to 40	Sandy loam	White Pine 99 Pitch Pine 1		*a* 517	0.7 to 0.8			4,396	*a* 17,500		5,000
New Hampshire	*r.*	35 to 40	Sandy loam	White Pine 100		*a* 794	(?)			3,818	*a* 15,500		
New Hampshire	*s.*	35 to 40	Sandy loam	White Pine 99 Maple 1		*a* 503	0.6 to 0.7			4,674	*a* 18,500		5,000
Massachusetts	*a.*	35 to 38	Sandy loam	White Pine 99 Hardwood, Hemlock 1		*a* 286 85	0.6			4,822	*a* 20,000		6,000
New Hampshire	*l.*	40	Loamy sand	White Pine 99 Red Pine 1		*a* 1,077	(?)			2,832	*a* 12,000		
Massachusetts	*g.*	40	Sandy loam	White Pine 100		*a* 323 35	0.8 to 0.2			5,378	*a* 22,000		
New Hampshire	*m.*	40 to 45	Sandy loam	White Pine 99 Hardwood 1		*a* 410 119	0.9			5,406	*a* 22,000		6,000
New Hampshire	*g.*	40 to 45	Loam	White Pine 99 Maple, Hemlock 1		*a* 371	(?)			4,503	*a* 18,000		
Massachusetts	*e.*	45 (cultivated.)	Loamy sand	White Pine 99 Birch 1		*a* 374 99	(?)			5,327	*a* 22,000		6,000
Pennsylvania	*j.*	40 to 50	Clay loam	White Pine 60 Hardwood, Hemlock 40	*a* 409 1,102	*a* 239 144	0.8			1,826	*a* 8,000		
Massachusetts	*k.*	48	Clay loam	White Pine 99 Hardwood 1		*a* 446 86	0.6			6,775	*a* 33,500		8,000
Massachusetts	*d.*	50	Clay loam	White Pine 99 Hardwood 1		*a* 295 47	(?)			4,923	*a* 25,000		
Massachusetts	*b.*	50 to 55	Sandy loam	White Pine 99 Hardwood 1		*a* 339 69	Full.			4,859	*a* 25,000		5,500
Massachusetts	*c.*	50 to 55	Sandy loam	White Pine 100		*a* 310 14	(?)			6,188	*a* 30,000		
Maine	*c.*	50 to 60	Gray loamy sand.	White Pine, ? 94 Hemlock, Spruce 6	*a* 348 180	*a* 328 160	0.7			4,070	*a* 20,000		5,500
Maine		50 to 60	Sandy loam	White Pine 99 Norway Pine, Hemlock 1		*a* 396	0.8			7,200	*a* 36,000		
Maine		50 to 60	Sandy loam	White Pine 82 Spruce, Red Pine 18	*a* 370	*a* 314 86	0.8			4,800	*a* 24,000		8,000
New Hampshire	*n.*	60 to 65	Sandy loam	White Pine 99 Red Pine 1		*a* 291	0.8 to 0.9			7,870	*a* 40,000		9,000
Pennsylvania	*c.*	60 to 80	Loamy sand	White Pine 40 Hemlock 9 Hardwood 51	*a* 216	*a* 80	0.5			2,918	*b* 14,000		11,000
Pennsylvania		60 to 80	Loamy sand	White Pine 66 Hardwood 27 Hemlock 7	*a* 232	*a* 154	0.6			5,036	*b* 24,173		12,000

Maine	*a.*	90 to 100	Loamy sand	White Pine	93	*a* 126	*a* 118	0.5	.....	.....	7,384	.....	.....	15,000
				Red Pine Red Oak	7									
Michigan	*i.*	95 to 105	Loamy sand	White Pine	47	*a* 364	*a* 173	0.7	8,500	33,400	7,165	*b* 28,650	87 (?)	12,000
				Hardwood	30									
				Hemlock	23									
Michigan	*a.*	100 to 150	Deep loose sand	Red Pine	61	*a* 181	*a* 68	0.6	6,800	33,000	2,990	*b* 14,350	44 (?)	10,000
				White Pine	36									
				Hardwood	3									
Michigan	*e.*	100 to 120	Sandy loam	White Pine	41	*a* 110	*a* 46	0.5	5,686	23,800	2,154	*b* 9,030	38 (?)	9,000
				Red Pine	59									
Michigan	*b.*	130 to 140	Deep loose sand	White Pine	68	*a* 189	*a* 129	0.7 to 08.	11,162	55,810	8,200	*b* 39,300	73 (?)	14,000
				Red Pine	14									
				Hemlock	18									
Michigan	*m.*	160 to 200	Fresh loose sand.	Red Pine	53	*a* 91	*a* 36	Open.	10,913	53,250	5,550	*b* 26,650	50	.....
				White Pine	39									
				Hardwood	8									
Michigan	.....	160 to 200	Fresh loose sand.	Red Pine	75	*a* 153	*a* 39	(?)	11,246	49,220	3,332	*b* 15,980	32 (?)	.....
				White Pine	25									
Michigan	*n.*	160 to 200	Loamy sand	White Pine	31	*a* 130	*a* 40	(?)	(?)	(?)	7,698	*b* 37,000	.....	.....
				Hardwood	69									
Michigan	.....	160 to 200	Fresh loose sand.	White Pine	39	*a* 91	*a* 36	Open.	10,900	53,000	5,550	*b* 26,650	50	.....
				Red Pine	53									
				Hardwood	8									
Wisconsin	*e.*	160 to 200	Clayey loam	White Pine	65	*a* 166	*a* 108	Open.	(?)	(?)	12,290	*b* 59,000	(?)	.....
				Hardwood	32									
				Red Pine	1									
				Fir	2									
Wisconsin	*e.*	160 to 200	Clayey loam	White Pine	49	*a* 110	*a* 54	(?)	(?)	(?)	9,200	*b* 41,160	(?)	.....
				Hardwood	51									
Wisconsin	*e.*	160 to 220	Clayey loam	White Pine	59	*a* 144	*a* 85	(?)	(?)	(?)	11,795	*b* 56,610	(?)	.....
				Hardwood	38									
				Fir	3									
Wisconsin	*g.*	160 to 230	Loamy sand	White Pine	54	*a* 143	*a* 77	(?)	10,150	47,820	8,682	*b* 41,660	86	.....
				Red Pine	9									
				Hardwood	24									
				Fir	13									
Wisconsin	*a.*	200 to 220	Fresh clay	White Pine	56	*a* 76	*a* 43	(?)	(?)	(?)	8,120	*b* 52,920	(?)	.....
				Hardwood	44									
Wisconsin	*a.*	200 to 220	Fresh clay	White Pine	52	*a* 32	*a* 69	(?)	(?)	(?)	15,840	*b* 95,000	(?)	.....
				Hardwood	48									
Wisconsin	*c.*	200 to 220	Light clay	White Pine	22	*a* 88	*a* 19	(?)	(?)	(?)	5,414	*b* 32,480	(?)	.....
				Hardwood	74									
				Fir	4									
Wisconsin	*c.*	200 to 220	Light clay	White Pine	44	*a* 136	*a* 60	(?)	(?)	(?)	12,136	*b* 72,810	(?)	.....
				Hardwood	53									
				Fir	3									
Wisconsin	*c.*	200 to 220	Light clay	White Pine	40	*a* 123	*a* 50	(?)	(?)	(?)	12,169	*b* 73,000	(?)	.....
				Hardwood	47									
				Fir	13									
Michigan	*k.*	230 to 240	Loamy sand	White Pine	80 (41)	*a* 110	*a* 76	0.8 to 0.9	20,060	92,000	12,174	*b* 58,400	61	20,000
				Red Pine	20 (18)	76								
				Hemlock	(41)									
Michigan	*k.*	230 to 240	Loamy sand	White Pine	51	*a* 118	*a* 60	0.5	21,076	115,560	16,586	*b* 99,400	71	30,000
				Hemlock	49									
Pennsylvania	*d.*	240 to 260	Rock, sandstone	White Pine	24	*a* 96	*a* 47	0.4 to 0.5	11,148	66,000	6,836	*b* 39,600	61	40,000
				Hemlock	60									
				Hardwood	16									
Pennsylvania	*f.*	240 to 260	Clay loam	White Pine	28	*a* 132	*a* 37	0.7	15,686	90,103	9,028	*b* 52,260	57	.....
				Hemlock	62									
				Hardwood	10									
Pennsylvania	*h.*	240 to 260	Clay loam	White Pine	30	*a* 78	*a* 23	0.5 to 0.6	11,224	66,900	7,269	*b* 43,500	65	40,000
				Hemlock	47									
				Hardwood	23									
Michigan	*g.*	250 to 260	Loamy sand	White Pine	50	(?)	*a* 44	0.7	(?)	(?)	10,385	*b* 62,300	.....	.....
				Hemlock	20									
				Fir	25									
				Hardwood	5									
Michigan	*d.*	250 to 270	Fresh loose sand.	White Pine	54	*a* 113	*a* 61	0.5	15,400	86,000	10,150	*b* 60,900	66	.....
				Red Pine	35									
				Hemlock	11									

a Lumber contents have been approximated.

b Lumber contents have been calculated by Doyle's log scale.

It may be of interest to record more especially the data of a small clump of young White Pine sprung up naturally on an abandoned field of less than three-fourths of an acre in extent, situated near Farmington, N. H., which its owner (Mr. J. D. Lyman, of Exeter) had from time to time thinned out for the last twenty-two years, with a view of accelerating the growth of the trees. Unfortunately, no record of previous conditions and frequency and extent of operations was attainable, but the present condition (three or four years ago) is exhibited in the following table:

Data of a clump of naturally grown young White Pine.

[Age: Forty-six to fifty-six years; average, fifty-one years. Height: 70 to 80 feet. Area: 108 square rods.]

Number of trees.	Diameter (breast high).	Volume.
	Inches.	*Cubic feet.*
1	22	85
1	21½	84
10	16 to 19	600
27	14 to 16	1,169
25	13 to 14	875
31	11 to 12	806
18	10 to 11	360
6	9 to 10	96
2	7	20
121		4,095

This would indicate a yield per acre of about 6,000 cubic feet, from which, with the dimensions attained under careful mill practice, some 36,000 feet of lumber might be cut. To be sure, with such open stand much of this must be knotty, even though the trees were pruned as far as possible.

By comparison with the measurements of naturally grown unthinned acres, we find that two to three times the number of trees of the age indicated in the above table might stand on an acre and make as much total product (see Massachusetts, site *c*, which, with 324 trees, produced 6,188 cubic feet); and although a few trees in the thinned grove had reached larger dimensions, the total product of trees over 12 inches in diameter is almost the same, the difference in favor of the thinned part being only 100 cubic feet. From this comparison it would appear that the thinning was too severe to secure the most desirable results. Pl. X shows the condition of the grove when the measurements were taken.

Allowance, however, should be made for the amount utilized in thinnings. Whether this inferior material would pay in most cases the cost of its removal is questionable. A very uncertain estimate by the man who performed the thinnings places the amount of wood removed equal to that now standing, among which is 5,000 shingles.

The following table shows the measurements of one of the largest trees in the grove:

Measurements of tree.

[Age: Fifty-six years. Height: 80 feet.]

Height of section, in feet.	Diameter, in inches.	Number of rings on section.
Stump	19½	54
10	14	46
20	12⅞	42
30	12½	37
40	10¾	32
50	8¾	24
60	5¾	15
70	3	8

This tree, when felled and cut into waney-edged boards, made lumber to the amount of 364 feet.

FIG. 1.—A THINNED PINE GROVE IN NEW HAMPSHIRE (TREES 51 YEARS OLD—186 TO THE ACRE).

FIG. 2.—YOUNG PINE IN NEW HAMPSHIRE (TREES 20 YEARS OLD).

DANGERS AND DISEASES.

The White Pine is subject to a considerable number of destructive influences even when growing spontaneously, but a large proportion of these might be avoided if properly understood and guarded against, since they are in great part due to human agency.

INJURIES BY HUMAN AGENCY.

The subject of forest fires has been so fully discussed that it is unnecessary here to treat it in detail, although the pine forests of the Northern States have suffered more irreparable injury from this than from all other destructive agencies combined. From the numerous suggestions that have been made respecting protection from fire and from unnecessary injuries in general, the most important appear to be:

(1) That a well-digested code of laws, capable of prompt enforcement, based upon the recommendation of a nonpolitical forest commission, is of primary importance.

FIG. 4.—Girdled White Pine continuing to grow.

(2) That a correct public sentiment, encouraged by a wider dissemination of information concerning the value of forest products and the time required for their growth, will have more influence than all other means together in preventing unnecessary destruction.

Unlike the Loblolly Pine of the Southern States, or the Red Pine with which it is commonly associated, White Pine has a thin bark during the first thirty to fifty years, which affords but slight protection from fire. Consequently, the species suffers much in young growths from surface fires, which do little or no harm to the thick-barked pines and hardwoods. In the mature trees the growing layer is much better protected, as the bark with age becomes proportionately thicker than that of Red Pine.

Related to the foregoing, and properly placed under the head of injuries to be charged to human responsibility, are wounds occasioned by cattle. A pine forest is less liable to injury from the browsing of cattle than one composed of deciduous trees, and in the Eastern States old pastures commonly grow up to pine, the deciduous species being kept down by the cattle. But in

any case, when the growth of timber is the primary object, domestic animals should be rigorously excluded, as they are certain to do more or less injury to the growing trees. A pine forest, or a forest of any kind, is no more properly a "run" for cattle than a field of standing grain, and the damage is likely to be more extensive and less capable of repair in the former than in the latter case.

The White Pine shows considerable recuperative power, which is exhibited in the ready reestablishment of broken leader and the healing of wounds, in which the prolific resin exudations assist by keeping out water and fungi.

The experiences of Mr. Nathaniel Morton, of Plymouth, Mass., in trimming pines, recorded in The Forester (June, 1898), show the absolute safety of pruning live limbs of 3 to 5 inches and more in diameter, which are covered in a few years by new growth (Pl. XI). An interesting case of pertinacity of life and recuperative power, which at the same time throws light on the much-debated question of food and water movement in trees, is also reported from the same source, and represented in fig. 4.

A young pine in the forest was, two years ago, not only girdled, but the bark peeled off for 11 inches all around the tree. The tree has a perfectly healthy appearance, and has continued to grow in length, although apparently about half as fast as before. The measurements of internodes of this tree during the last six years follow. The diameter growth above the wound has continued, while below the wound it has remained stationary, as will appear from the measurements made two years after the removal of the bark.

	Inches.
Circumference near the ground	15
Circumference just below the wound	11
Circumference where bark is stripped	9¼
Circumference just above first row of branches	11
Circumference above second row of branches	11

The wound is entirely covered by pitch. The growth just above the wound has a baggy appearance, showing an accumulation of wood deposit, which shows the arrest of the food materials due to the absence of the cambium layer and bark.

It would appear that the roots could either live without the food supply from above (at least for two years), or else that a sufficient amount can pass through the dead wood of the trunk, and at least the water necessary for the elaboration of food materials in the foliage can be supplied through the old wood. The writer inspected this tree, and can vouch for the truthfulness of the description. A similar case with a southern pine (species undetermined) came to his attention, where the tree was older and had grown over twenty years above the wound; but as only a cut was inspected the possibility of a cambial connection of the upper and lower parts was not absolutely excluded, as in the present case.

INJURIES BY STORMS.

Of injuries not within human control may be mentioned, first, those resulting from storms, snow, and ice. The soft texture of the wood and the short-lived branches of the White Pine would naturally suggest its being more liable to injury by storms than are deciduous trees. This, however, is not the case. The angle which the branches make with the trunk admits of their readily bending, and under such a weight it is found that Maples and other hardwood trees break down much more frequently. Mr. B. F. Hoyt, of Manchester, Iowa, states that "a whole summer's observation among the White Pines of Tennessee failed to reveal a single case in which a tree of that species was injured by the wind," attributing the fact to the mechanical disposition and structure of the trunk and branches.[1] In this respect, then, the White Pine stands at a decided advantage as compared with many deciduous trees with which it is naturally associated.

Like the shallow-rooted Spruce, the White Pine is liable to be uprooted and thrown by storms, although to a less degree.

While, however, the mechanical effects of the wind and of storms of snow and ice are not sufficient to require special consideration, the injurious consequences of drying winds are such as

[1] American Naturalist, December, 1886.

FIG. 1.—YOUNG PINE IN NEED OF PRUNING.

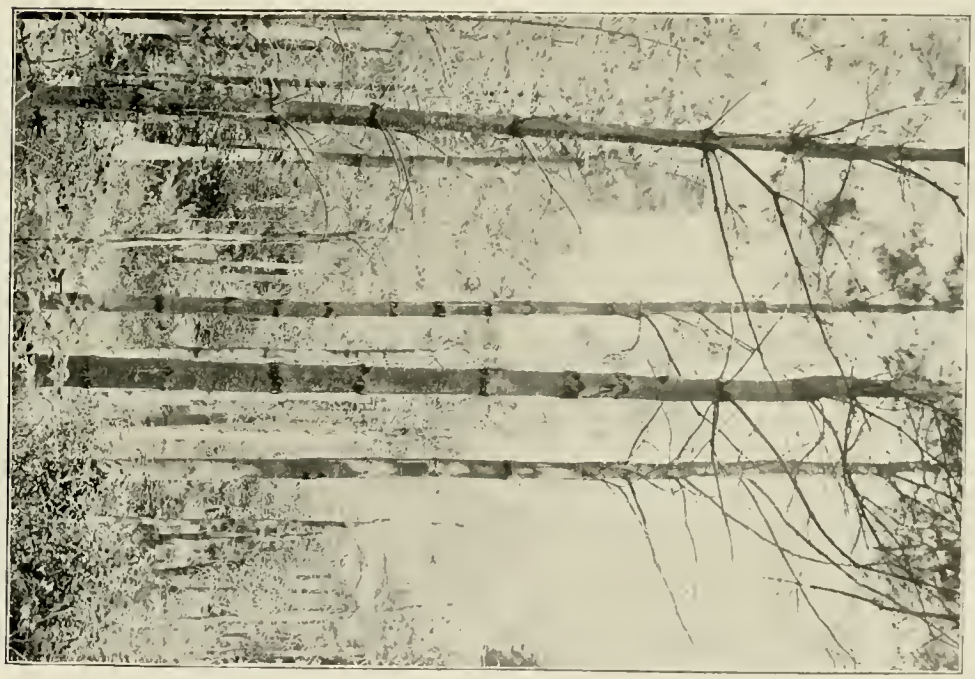


FIG. 2.—YOUNG PINE PRUNED.

to become an important factor in determining the limits of the artificial cultivation of this species. At the time of planting, deciduous trees are not in leaf, and accordingly there is but little evaporation of water, while the leaf surface of conifers is exposed then as much as ever to the drying effects of the atmosphere, often resulting in their death before they are fully established in the soil. It is for this reason and because of the general lack of a sufficient amount of atmospheric moisture that comparatively slight success has attended the cultivation of the White Pine on the plains west of the Mississippi. The raw winds from the Atlantic again have been found to be much more injurious to this species than to the Pitch Pine (*Pinus rigida*), and the latter is therefore decidedly preferable for planting in the immediate vicinity of the coast.

DISEASES

EFFECT OF HEAT AND DROUGHT.

In Germany, plantations of White Pine thirty-five to forty years old have suffered much injury from a disease which appears to be occasioned by unusual heat and drought, and which was particularly severe after the hot, dry summer of 1876.[1] The disease manifests itself externally by dried-up patches on the trunks, the spots being largest 3 to 6 feet from the ground, gradually running out above and below this, and often reaching a height of 15 to 18 feet. The spots may be only an inch or two wide, but frequently the bark is dead nearly around the entire trunk. As a rule, these dead spots are on the south and west sides of the tree. The wood is often penetrated by larvæ of insects, but these are not the cause of the disease, since in many cases they are not present.

Dr. R. Hartig, from a comparison of specimens and study of the disease in question, concludes that it is due to extreme dryness and that the White Pine can not be trusted to endure such extremes. He further states that it suffers greatly from dry air even in the winter time.

PARASITIC DISEASES.

The White Pine is subject to a number of parasitic diseases, some of which attack it when growing spontaneously in the forest, while others are highly destructive to the tree in cultivation, especially in Europe under changed climatic conditions. A few only of the best known of these, including several due to fungi, will be considered in detail.

(1) *Agaricus melleus* Vahl.—This fungus, of common occurrence in the United States as well as Europe, is exceedingly destructive to coniferous trees, the White Pine in particular suffering greatly from its attacks. It also fastens upon various deciduous species as a parasite, attacking living trees of all ages, but living as well upon dead roots and stumps and on wood that has been cut and worked up, occurring frequently on bridges, railroad ties, and the like, and causing prompt decay wherever it has effected an entrance. The most conspicuous part of the fungus is found frequently in the summer and fall on the diseased parts of the tree or timber infested by it. It is one of the common toadstools, this particular species being recognized by its yellowish color, gills extending downward upon the stem, which is encircled a little lower down by a ring, and by its habit of growing in tufts or little clumps of several or many individuals together (Pl. XII, *1* and *2*). It is also particularly distinguished by the formation of slender, dark-colored strings (Pl. XII, *2* and *3*), consisting of compact mycelium, from which the fruiting parts just described arise. These hard root-like strings (called rhizomorphs) extend along just beneath the surface of the ground, often for a distance of several feet, and penetrate the roots of sound trees. By carefully removing the bark from a root thus invaded the fungus is seen in the form of a dense, nearly white, mass of mycelium (Pl. XII, *3*, *c*), which, as the parts around decay, gradually produces again the rhizomorphs already described. These rhizomorphs are a characteristic part of the fungus. Occurring both in the decayed wood, from which they spread to the adjacent parts, and extending in the soil from root to root, they constitute a most effective agency in the extension of the disease.

The symptoms of the disease are marked, and, taken together, sufficiently characteristic to admit of its ready recognition. External symptoms, to be observed especially in young specimens

[1] Hartig. Untersuchungen aus dem Forstbotanischen Institut zu München, 1883.

recently attacked, consist in a change of the leaves to a pale sickly color and often the production of short stunted shoots. A still more marked symptom is the formation of great quantities of resin, which flow downward through the injured parts and out into the ground, resulting in the sticking together of the roots and masses of dirt that have been penetrated by the resin. Passing up a little way into the trunk, the cause of this is seen in the active working of the fungus in the medullary rays and around the resin canals, where apparently both cell walls and cell contents undergo degeneration and partial conversion into resin. This flows downward, as already stated, and also works laterally into the cambium, producing great blisters in the younger parts where growth is going on, and also resulting in the formation of abnormally large resin canals.

As the disease advances the fungus continues to attack the tracheids of the sound wood and soon induces marked changes. Under its influence the walls lose their lignified character, become softer, and give the cellulose reaction, while the mycelium of the fungus penetrates and fills the enlarged cavities of the tracheids. (Pl. XII, *4*, *5*, *6*.)

The whole inside of the trunk may finally become hollow for some distance above the stump, its interior being filled with a loose rotting mass, penetrated by rhizomorph strings, and only becoming worse the longer it stands. The disease having once reached this stage, there is of course nothing to be done for the tree but to fell it as soon as possible and save whatever wood remains unaffected.

(2) *Polyporus annosus* Fries (*Trametes radiciperda* R. Hartig).—This is one of the most dangerous parasites of coniferous trees, causing "red rot" and the dying out of plantations both of young and old pines. In Germany it infests various species of pines, including *Pinus strobus* and *Pinus sylvestris*; also *Picea excelsa*, *Juniperus communis*, and others. It is more destructive to the White Pine than to the Scotch Pine.

The disease appears in plantations of various ages, from five to one hundred years old, showing itself by single plants here and there becoming pale, then yellow, and suddenly dying. These external symptoms are altogether similar to those observed in trees infected by *Agaricus melleus*. Other trees are attacked in the neighborhood of the infected ones, and so the disease spreads centrifugally.

The fruiting portion of the fungus (Pl. XIII, *1* to *6*) grows on the roots near the surface of the ground, forming yellowish-white cushions (white on the spore-bearing surface) that may finally, though rarely, become a foot or more in diameter. Between the wood and bark of the affected tree are extremely thin layers of mycelium, distinguished from those of *Agaricus melleus* by their softness and delicacy. The tissue of the roots and the inside of the stem is decayed to a considerable height.

The disease is spread by the spores, which are carried away by mice and other burrowing animals and deposited on the roots of adjacent trees, where they germinate and penetrate the living tissues of the bark, passing thence into the wood elements and growing in them toward the stem. It is also communicated by the roots of infected trees crossing those of sound ones in the ground (Pl. XIII, *7*), the fungus growing directly from one to the other.

A violet discoloration of the wood is the external symptom of beginning decomposition, in which the contents of the parenchyma cells die and turn brown through the action of the mycelium. This color disappears with the loss of the cell contents, and a clear brownish-yellow takes its place, with scattering black spots here and there. These are surrounded at a later period with a white zone (Pl. XII, *8*), and at the same time the wood becomes continually lighter and more spongy. At last numerous openings arise, the wood is separated into its constituent fibers, and becomes watery and of a clear brownish-yellow color. The cell wall undergoes decomposition, giving the cellulose reaction instead of remaining lignified, and finally even the entire middle lamella disappears. The process may go on until the wood elements are isolated, so that they are easily picked apart like threads of asbestos.

The parasite advances rapidly in the wood elements, decomposition sometimes going on in this way to the height of 25 feet. In the bark it proceeds more slowly, but is finally none the less dangerous, since it causes the death of the cortical part of the root in which it originates, and when after reaching the trunk it passes into the other roots, their death finally resulting in the death of the whole tree.

In the Scotch Pine a great amount of resin is produced, and this, accumulating in the lower part of the stem, probably acts as a barrier to the growth of the mycelium upward. In the White Pine the fungus extends much farther in the trunk.

Pl. XII, *7*, represents a stump of White Pine that has been attacked by *Polyporus annosus*. The heart is surrounded by decayed wood and spots filled with masses of resin. Pl. XII, *9*, represents parts of adjacent wood elements of Norway Spruce after they have been acted upon by the fungus; the mycelium hyphæ and spores, highly magnified, are represented in *10* of the same plate.

(3) *Coleosporium senecionis* Pers.—This fungus, under the name of "pine blister," infests various species of pines, growing in the æcidium stage on both leaves and bark, and sometimes proving very destructive. When growing on the leaves it affects but little the vitality of the tree, but is highly injurious when the bark is the place of attack. It penetrates the bark, apparently through wounds occasioned by insects, woodpeckers, or other agencies, and its mycelium spreads through the cortical parenchyma and bast, and into the wood to the depth of several inches, passing through the medullary rays.

Under its influence the starch and other cell contents disappear and a resinous substance collects in their stead, a mass of dead tissue soon taking the place of the living cells. This change of the cell contents results in a great accumulation of resin, which often exudes in large quantities from the diseased parts of the tree.

The mycelium is perennial, extending itself through the stem from year to year, particularly in a longitudinal direction. Where it is present the growth of the stem is prevented and the formative materials are diverted to the opposite side of the stem, causing there a greatly stimulated and abnormal growth. The death of the leader often results, especially in dry summers, for the reason that the wood, thus choked with resin, is unable to supply it with sufficient water.

The researches of Wolf lead to the conclusion that this parasite of the pine lives in the form known as *Coleosporium senecionis* on various species of Senecio, and that it is communicated to pine shoots from them. He proposes the extermination of these hosts as a preventive measure. Later investigations of Kleebahn go to show that a blister rust which he observed badly affecting the bark of *Pinus strobus*, in the neighborhood of Bremen, is caused by a closely related parasite form which he names *Peridermium strobi*, and considers to be the æcidium stage of *Cronartium ribicola*.

All these fungi have probably caused far more destruction of timber than casual observation would indicate, but the limited extent to which artificial cultivation of forests has thus far been carried on in this country gives comparatively few exact data regarding them. The facts, as above stated, have therefore been drawn largely from the works of Hartig and other European authorities. With increasing cultivation of timber and probable increase of such diseases, their investigation and the employment of protective measures must necessarily receive far more attention.

Several diseases attributable to the action of fungi, but as yet imperfectly investigated, are of frequent occurrence in this country. One of these, known as "damping off," characterized by the sudden decay of seedlings at the surface of the ground, is common in nurseries, and attacks young plants of different kinds, the White Pine among them.

The disease is most prevalent in plants growing in a damp soil in a warm, moist atmosphere. As observed in the Ann Arbor (Michigan) greenhouses for several years in various plants propagated from slips, the disease appears a few days after the slips are set, giving the lower part of the stem a wet, unhealthy appearance, which extends to the lower leaves, particularly where these touch the sand in which they are growing. Upon taking up the specimens, the parts affected are found to be in the early stages of decay, and penetrated throughout, even in the interior of the epidermal appendages, by the branching filaments of a fungus. The fungus appears to live in the sand in which the plants are propagated, and to run in it from one to another, resulting often in the rapid destruction of the plants in the bed.

"Damping off" is due to the action of several different parasitic organisms, of which the potting-bed fungus, *Pythium de baryanum* Hesse, is one of the most common, though a number of other species have been shown to be capable of producing the disease. The relief measures recommended by those who have studied the disease are the use of fresh soil free from decaying

matter, as much sunlight as the plants will endure without wilting, a fairly low temperature, and an abundant supply of fresh air. Mr. J. Dawson, of the Arnold Arboretum, suggests watering the young plants from below, so as to avoid wilting the leaves, as a means of prevention. Other suggestions will be found in recent literature of the subject, practically in the reports of various agricultural experiment stations.[1]

A disease which attacks the trunk of the tree, at various ages, is very prevalent in pine forests, and occasions the condition known among lumbermen as "punky pine." A diseased tree can frequently be recognized by its having one or more knots with a rough, irregular contour, at a considerable height above the ground, commonly conspicuous by a considerable outflow of resin. These seem to result from the breaking off of branches, followed by gradual decay at the place where they have separated from the tree, in such a way as to admit water into the trunk, the opening being afterwards partially covered by subsequent growth of the tree while decay is going on inside.

Upon examining the wood of such a tree, it is seen to be discolored and in various stages of decay, the diseased condition extending inward from the knot hole, and both upward and downward from it in the trunk. By inspecting logs cut from such trees, it will be noticed that the decayed portion may have filled up the center, making a rotten heart; or it may follow the rings of growth for some distance, midway from the center to the periphery; or it may be still nearer to the surface, its position and extent being very variable and following no recognizable rule. The parts diseased are utterly worthless, though boards containing a greater or less amount of wood thus affected are common in the market. Microscopic examination shows that the wood is penetrated by the filaments of a fungus, and that the elements of which the wood is made up have been greatly altered, and to a considerable extent decomposed by its action.

Continued observation in the pine woods of Michigan, in different years, does not so far justify the reference of this disease to any single species of the various fungi found growing upon the trunks and logs of decaying pine trees. But whatever the species, one or several, concerned in producing or hastening the condition described, the general facts, as stated above, appear to be that the disease finds its way where the separation and decay of a branch presents a favorable place for the entrance of water and the spores of fungi, and that it spreads so extensively in the trunk as to entirely ruin large and valuable trees.

In our natural forests there is, of course, neither remedy nor prevention, but in artificial cultivation careful and seasonable pruning would doubtless be the most effectual preventive, since, if properly performed, the wounds left by the removal of branches would soon be grown over and there would be no further danger from this source.

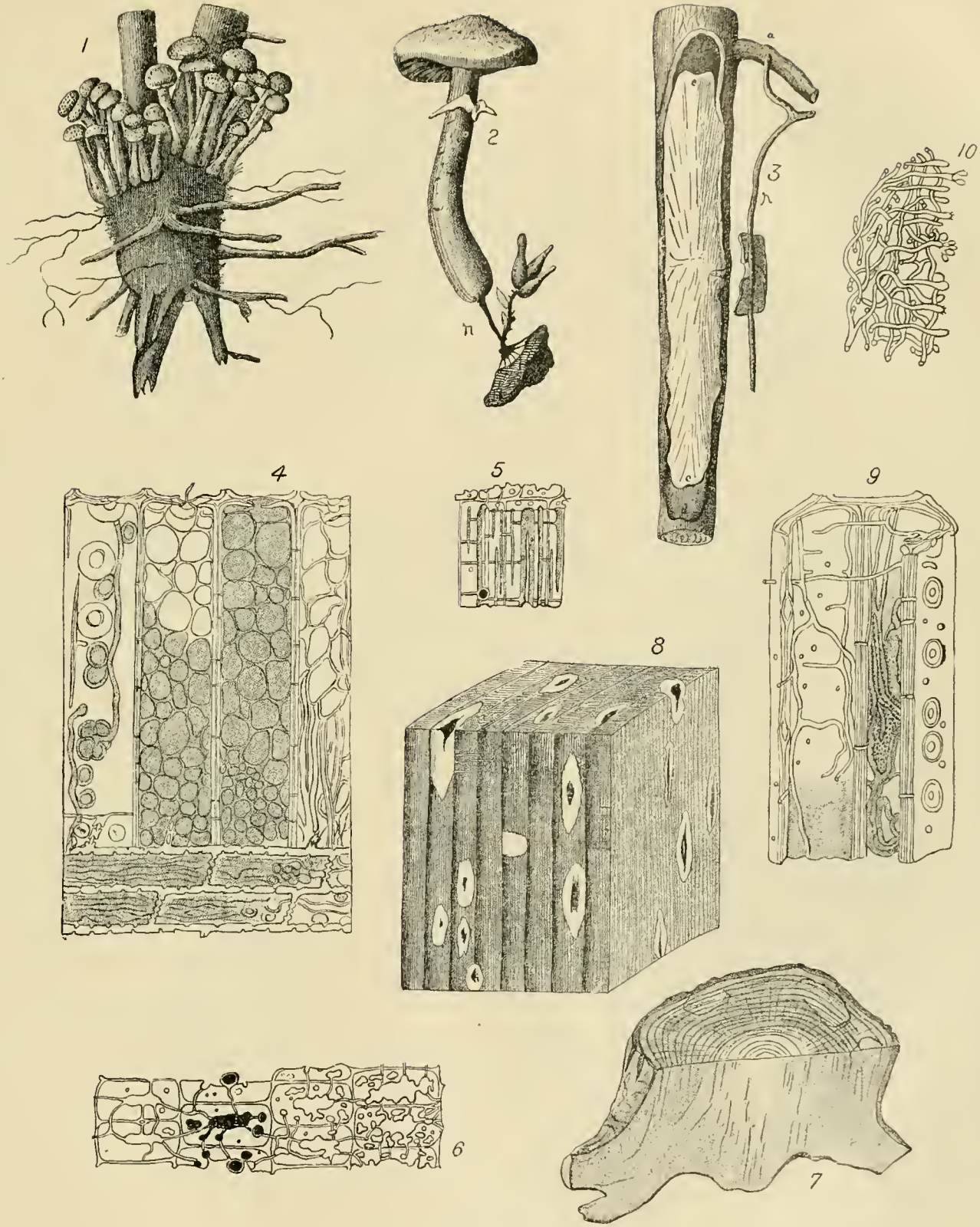
EXPLANATION OF PLATE XII.

1. *Agaricus melleus*, cluster of young sporophores.
2. *Agaricus melleus*, larger sporophore with root-like organ of attachment.
3. Root of spruce tree invaded by mycelium of *Agaricus melleus;* rhizomorph of same fungus on the right.
4–6. Fragments of pine wood showing the destructive action of *Agaricus melleus.*
7. Stump of White Pine attacked by *Polyporus annosus:* the heart is still sound, but is surrounded by decayed wood and spots filled with masses of resin.
8. Wood of Norway Spruce in early stages of decay occasioned by action of *Polyporus annosus:* the white areas have become delignified, and the wood elements composing them are soft and easily separable.
9. Wood elements of Norway Spruce isolated and showing the mycelium of the *Polyporus annosus.*
10. Fruiting hyphæ and spores of *Polyporus annosus.*

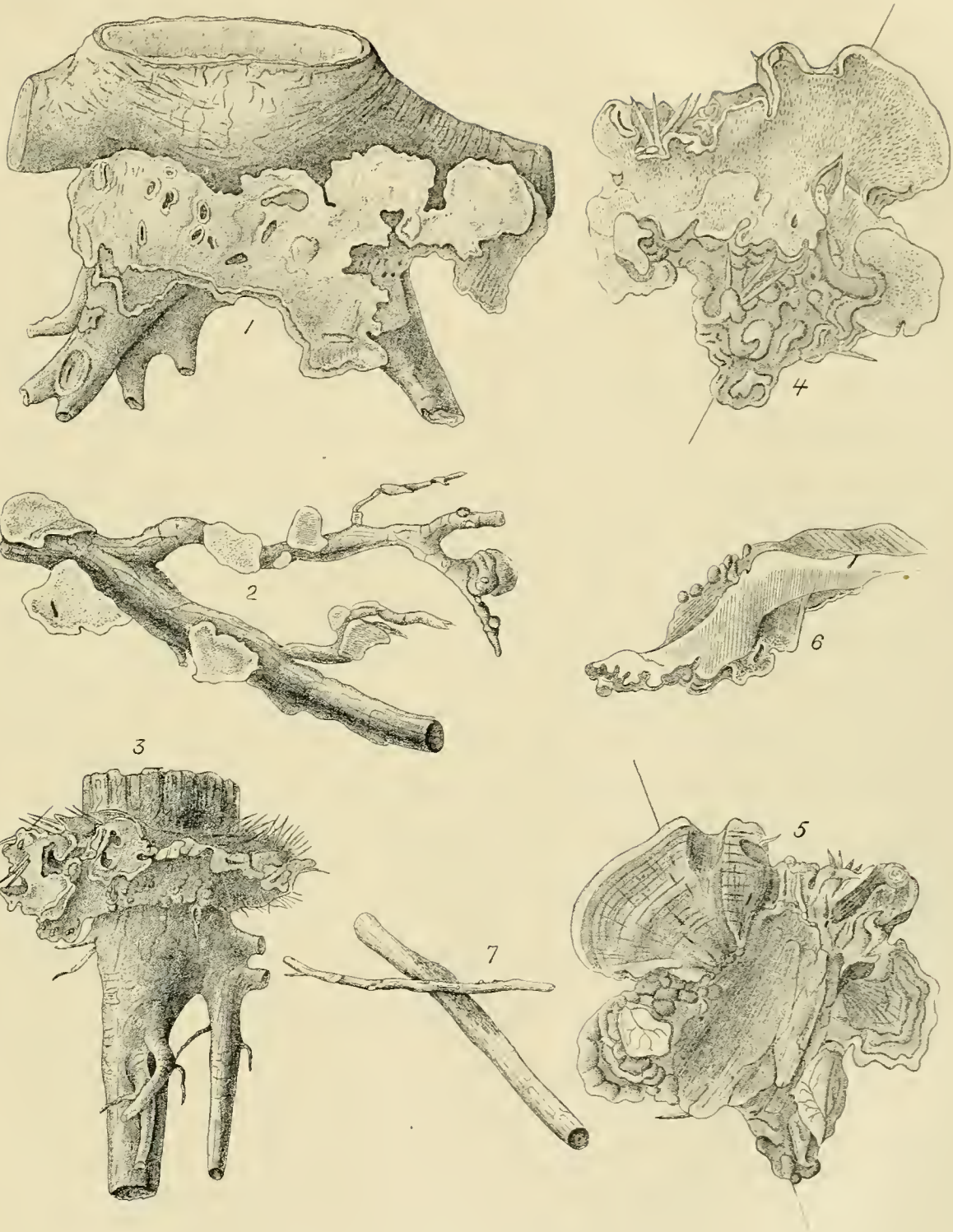
EXPLANATION OF PLATE XIII.

1. Stump of Norway Spruce, with a sporophore of *Polyporus annosus* several years old; the inner portions of the stump wholly decayed.
2. Roots of a diseased spruce tree, with numerous small sporophores of *Polyporus annosus* attached.
3. Stump and part of root system of a young pine tree killed by the action of *Polyporus annosus,* the sporophores of which have grown entirely around the base of the trunk.
4. Mature sporophore of *Polyporus annosus* seen from below, showing the porous spore-bearing surface.
5. Mature sporophore of *Polyporus annosus* from above, showing the velvety upper surface and concentric bands.
6. Mature sporophore of *Polyporus annosus* in section.
7. Mode of infection; where the smaller diseased root crosses the larger one, the mycelium of the *Polyporus annosus* has penetrated the latter and spread in both directions for some distance.

[1] Cf. Atkinson, Cornell Univ., Agr. Exp. Sta. Bull. 91, 1895.



DISEASE OF WHITE PINE: AGARICUS MELLEUS.



DISEASE OF WHITE PINE: POLYPORUS ANNOSUS.

INSECT ENEMIES OF THE WHITE PINE.

By F. H. Chittenden, *Division of Entomology.*

INTRODUCTION.

Of all coniferous plants, perhaps none are more subject to insect attack than the White Pine. Upward of a hundred species are reported to affect this tree, and a careful compilation of all known species would probably add many more to this list. The more important are found in the order Coleoptera, and of these the cylindrical bark-beetles of the family Scolytidæ hold the highest rank. Most of the Scolytidæ live within the cambium of dead or dying trees, but a few penetrate the solid wood, and several forms, when excessively abundant, do not hesitate to attack healthy growth. Numerous other Coleoptera belonging to the families Cerambycidæ and Buprestidæ similarly infest the White Pine, but are for the most part secondary in the nature of their attack, and will therefore require only passing mention. One species, however, the white-pine weevil (*Pissodes strobi* Peck), is a pest of the most pernicious type. In addition to the bark-boring and wood-boring insects, several species infest the roots, some only the branches or twigs, some the cones, and others injure growing trees by defoliation. The leaf-feeding species comprise the larvæ of several sawflies, the caterpillars of numerous moths, and a number of beetles. Various species of plant-lice and scale insects also occur upon the leaves, and often the limbs and trunks of trees are injured by them.

Most of our injurious forest insects are native to this country, in which respect they differ markedly from those which affect field and garden crops. Only such species as experience has shown to be more or less injurious either to living trees or to cut timber will be considered in this paper. Some few forms that have not been recorded on White Pine are mentioned, as it is more than probable that they are capable of injury to this tree. The majority, however, have been observed on White Pine.

In the preparation of the present paper the writer has drawn freely from the published works of Packard, Fitch, and Hopkins, as well as from personal experience in pine forests, particularly of New York.

THE DESTRUCTIVE PINE BARK-BEETLE.

The last decade witnessed very extensive destruction of pine and spruce forests in portions of the United States east of the Rocky Mountains. The principal injury, which dates from about the year 1888, has been attributed to the so-called destructive pine bark-beetle (*Dendroctonus frontalis* Zimm.), one of a genus of six described species, all of wide distribution and all destructive to the Coniferæ. It is quite possible that some predisposing agency had first caused a weakened condition of the trees in the infested districts, but it is fairly certain that this species of beetle was responsible for much injury. The infested area observed comprised the pine and spruce forests from Maryland in the North to and including North Carolina in the South, an area estimated at upward of 10,000 square miles in extent. In some sections entire forests were killed.

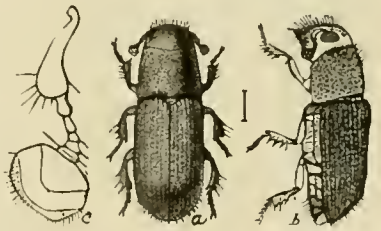


Fig. 5.—*Dendroctonus frontalis*: *a*, dorsal view of beetle; *b*, lateral view—enlarged about six times; *c*, antenna—greatly enlarged (author's illustration).

The accompanying illustration of this species (fig. 5) will enable its recognition. It ranges from reddish to dark brown in color, and measures about one-eighth of an inch in length, being the smallest species of its genus. Its credited distribution includes Lake Superior to Georgia, and it is recorded also from Arizona and California. The adult beetle appears some time in May, the date depending upon season and locality, bores into living trees and its larvæ develop under the green sappy bark. Copious quantities of turpentine exude from the holes made by the beetles and dry in masses upon the bark. The manner of work of the larvæ in great numbers beneath the bark produces about the same effect as that of girdling, thus cutting off the flow of sap, the natural supply of plant food and moisture, greatly weakening and eventually killing the trees. The first outward manifestation of injury is the accumulated masses of pitch, followed by the leaves turning yellow and then red, as though scorched by fire.

A singular feature in connection with the irruption of this species is that it was practically unknown save in the collections of specialists until its sudden appearance in 1888, but still more remarkable is its unaccountable, but almost entire, disappearance in 1893, not, however, before it had done a great amount of damage, which has been estimated at upward of a million dollars. The apparent extermination of this bark-beetle in the district where it was most destructive is believed to have been due to a fungoid disease.

REMEDIES.

After boring insects of this class once gain access to a tree it is practically impossible to eject them, and to save the tree recourse must be had to preventive measures. For this purpose various protective washes are in use. One of these consists of lime, to which has been added a sufficient quantity of Paris green to give it a slight green color and enough glue to cause it to be adhesive. Another wash consists of soft soap reduced to the consistency of a thick paint by the addition of washing soda in water. A thick wash of soap, plaster of Paris, and Paris green is also of value. A carbolated wash, which is in successful use against the peach-tree borer, is prepared by mixing a pint of crude carbolic acid with a gallon of soft soap in eight gallons of soft water. Fish or train oil is valuable as a deterrent, but should not be used except with the greatest caution upon young trees. Whatever wash is employed should be applied to the trees on the first appearance of the beetles in May, and should be renewed if found necessary.

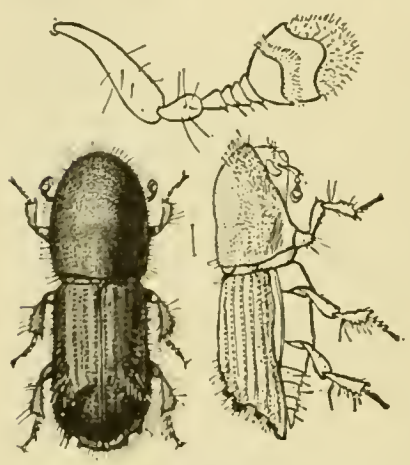


FIG. 6.—*Tomicus cacographus*: beetle, showing dorsal view at left, in profile at right—enlarged about ten times; antenna above, highly magnified (original).

Better than any other measure, however, is the observance of clean cultural methods. Owners of pine forests or groves will do well to cut down all dead and trim all injured trees. For the protection of pines, dead spruces and other coniferous trees, and such as are infested and too much weakened to recuperate, should be cut down and destroyed by burning. A great deal of good can be accomplished merely by removing the bark of dead timber. The progeny of the insects that have deposited their eggs in one season so loosen the bark that it is an easy matter to remove and burn it before the following spring. By pursuing this method millions of the insects will be destroyed before they have an opportunity to issue and lay their eggs for the destruction of other valuable trees. A practice known as "rossing" is in use on borer-infested lumber in Canada. It consists in cutting a strip of bark along the full length of the upper side of a log, which causes the bark to dry up and eventually drop away.

OTHER INJURIOUS BARK-BEETLES.

Of the other species of Dendroctonus, one has recently been reported as ravaging the spruce forests of New Hampshire. It is the species at present known as *D. rufipennis* Kby., and although not known to affect White Pine, it is not impossible that it might attack this tree in case it extends its present depredations. The species of Dendroctonus are peculiarly periodical in their attacks. There is, however, one exception, *D. terebrans* Ol., which is usually common at all times over a very wide area of the United States and Canada, infesting all the pines. According to information received in May, 1898, this or a related species is now ravaging the pine forests of a portion of southern New Jersey.

The genus Tomicus contains perhaps quite as dangerous forms as those which have just been mentioned. The appearance of the beetles is somewhat similar, as is also their method of life. A species that has been associated with the mortality of pines in the region about and south of the District of Columbia is *T. cacographus* Lec., or southern pine bark-beetle, which is illustrated much enlarged at fig. 6. It is reddish in color and may be readily separated from any of the preceding

species by the structure of its antennæ and by the toothed apex of the elytra or wing-covers. Its mine is shown as it appears on the under side of the bark of a tree at fig. 7.

Tomicus pini Say, the northern pine bark-beetle, is destructive to pine forests in the North in a very similar manner to the preceding species, which it much resembles in structure as in habit, but is less injurious farther South. *T. calligraphus* Germ., a similar species to the two preceding and about equally destructive, abounds in the pine woods of both the North and South, and *T. exlatus* Zimm. and *T. arulsus* Eich. also infest White Pine.

Among other well-known white-pine bark-beetles may be mentioned *Crypturgus pusillus* Gyll., *Hylurgops glabratus* Zett., and several species of Hylastes and Dryocœtes.

The remedies to be employed against these insects are practically the same as for the destructive pine bark-beetle.

FIG. 7.—Galleries of *Tomicus cacographus* on wood under bark of pine (original).

TIMBER-BEETLES AND OTHER SCOLYTIDÆ.

While the majority of the pine-infesting Scolytidæ breed between the bark and the wood, a considerable number, called timber-beetles, live entirely within the sapwood; others, the twig-beetles in the small twigs and branches, and a third group, represented by *Pityophthorus coniperda* Sz., inhabits the cones.

The chief danger from the bark-beetles, as has been shown, is from their attacks on living trees. They do comparatively little damage to timber, except as they loosen the bark and thus afford ready access to water and mold and to other destructive insects. The timber-beetles, or ambrosia beetles, as they are sometimes called, live almost exclusively in greenwood, preferring that which is slightly injured, of impaired vitality, or such as has been newly felled, but they often attack and kill healthy growth, and in the process of their work in timber cause a staining or "bluing" which entails a still greater loss than results from their direct attack to living trees. The presence of these beetles in a tree is manifested by the little piles of white sawdust which they eject from the "pin-hole" entrance to their galleries. The pine timber-beetles are found in the genera Gnathotrichus, Xyloterus, Xyleborus, and Platypus. *Gnathotrichus materiarius* Fitch is the commonest of three species of the genus, all of which attack pine. This species is shown greatly enlarged at fig. 8, and its characteristic galleries in the wood of pine are well illustrated at fig. 9.

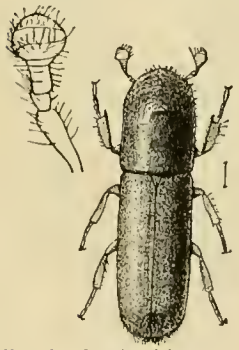


FIG. 8.—*Gnathotrichus materiarius:* beetle, enlarged; antenna, still more enlarged at left (Marx del.).

The same remedies advised against bark-beetles will prove valuable against the timber-beetles. Kerosene emulsion or a carbolated wash would accomplish the destruction of the timber-beetles even after they have attained entrance to a tree, provided the application be made in time.

The twig-beetles are represented by the genera Pityophthorus and Hypothenemus. Of the former genus, *P. sparsus* Lec., *cariniceps* Lec., *pullus* Lec., *lautus* Eich., *plagiatus* Lec., are all well-known pine species. The genus Hypothenemus inhabits alike deciduous and coniferous trees.

Remedies are the same as for bark-beetles. Pruning and burning infested twigs and branches and the clearing away and burning of brush heaps during winter are indicated. For choice ornamental trees in private grounds and in parks plugging the "pin holes" with wire and stimulating the trees with manures and fertilizers to assist them to recuperate from attack are advisable.

PINE SAWYERS AND OTHER BORERS.

Of all the insects that occur in pine timber the Cerambycid, or long-horned beetles, of the genus Monohammus, are the best known, and are credited with being the most destructive. If

we except the losses occasioned by the more or less sporadic attacks of certain species of the Scolytidæ already mentioned, probably this opinion is about correct. Five of these species have been described, all pine feeders and beetles of the largest size, with elongate cylindrical bodies and extremely long antennæ, those of the male being two or three times as long as the remainder of the insect. The pine sawyers are most troublesome in the mill yard, and their large white larvæ often do much damage to logs by eating great holes through their solid interior. While burrowing in the wood the larvæ make a peculiar grating sound that may be heard on quiet nights at a considerable distance. This is a familiar sound in the lumber camps of the North, and has probably

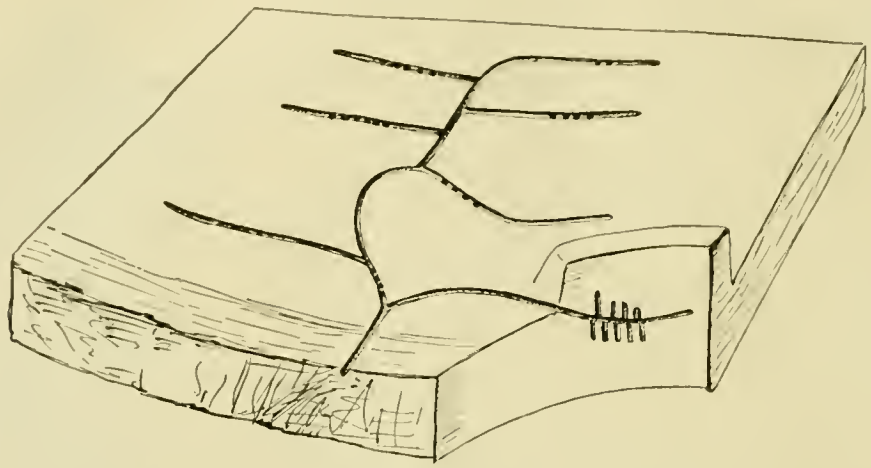


FIG. 9.—Gallery of *Gnathotrichus materiarius* in pine (adapted from a drawing by A. D. Hopkins).

given rise to the name of pine sawyers, by which these insects are known. *Monohammus confusor* Kby. is a large gray species destructive in the lumbering districts of the Northern United States and Canada; *M. titillator* Fab., a mottled brown beetle, replaces the above species in the South, and *M. maculosus* Hald. occurs in the West; *M. scutellatus* Say. is widely distributed and abundant from the Atlantic to the Pacific, and *M. marmorator* Kby. is a rather rare northern form.

Among other borers belonging to the same family as the sawyers, the majority of which infest White Pine, may be mentioned *Criocephalus agrestis* Kby., *C. obsoletus* Rand., *Asemum mastum* Hald., *Orthosoma brunneum* Forst., *Prionus pocularis* Dalm., *Hylotrupes bajulus* Linn., *Callidium antennatum* Newm., *Rhagium lineatum* Ol., *Graphisurus pusillus* Kby., *Acanthocinus obsoletus* Ol., *A. nodosus* Fab., and *Neoclytus muricatulus* Kby.

FIG. 10.—*Chalcophora virginiensis*—natural size (Marx del).

In the Coleopterous family Buprestidæ are many borers which infest pine. These include five species of Chalcophora, one of which, *C. virginiensis* Dru., is figured (fig. 10); *Dicerca punctulata* Sch., *D. tenebrosa* Kby., *Buprestis striata* Fab., *Melanophila fulvoguttata* Harr., *M. longipes* Say., *Chrysobothris dentipes* Germ., *C. floricola* Gory, and *C. scabripennis* Lap. and Gory. These beetles are graceful in form, hard of texture, and many are brilliantly metallic. Their larvæ are slender, white grubs with very large, round flat heads. Some of this family attack living trees and do injury to the sapwood and to felled timber in the same manner as the sawyers, but the majority of them prefer devitalized material, and their attacks are usually secondary to some more injurious species.

THE WHITE-PINE WEEVIL.

In the White Pine forests of the Northern States, particularly in those of a second growth, one's attention is often drawn to the great number of deformed trees. They sometimes occur singly, but more often in groups. The insect that is responsible for this damage is the white-pine weevil (*Pissodes strobi* Peck). This beetle is a member of the family Curculionidæ, and is about a fourth of an inch in length, of oval form, red and brown in color, with its elytra marked with white

spots, as shown in the accompanying illustration (fig. 11). It is provided with a rather long rostrum or snout to which are attached its elbowed antennæ. The larva, which is white and footless, is illustrated at *a*, and the pupa, also white, is figured at *b*.

This weevil is one of the first spring visitants in the North, occurring as early as March about Washington City and in April or May farther north. Its eggs are deposited on the terminal shoots of pine, particularly of young trees, but sometimes also in the bark of old trees. The larva, when hatched, bores into the pith or mines the sapwood. Toward the end of summer it attains full growth, when it goes into hibernation until the next spring, transforming to pupa and soon afterward to the mature or beetle form. The presence of this insect in a tree is first manifested by the wilting of the leading shoots, which becomes most evident toward the close of summer. The identity of the species at work may be established at once from its peculiar cells beneath the bark. (See fig. 12.) These cells, which are destined for its winter nest and for further transformation, are sunk into the pith and covered over with long fibers of chipped wood. When a terminal shoot of a small tree becomes filled in the summer with these larvæ, to the number sometimes of a score or more, the shoot, with its lateral branches, as well as the stock below, wilt and gradually die, the bark becomes loosened, pitch oozes out, and by autumn the shoot turns black, and the bark is covered with masses of pitch. A tree thus damaged will fail sometimes for several successive seasons to send out a new terminal shoot, with the result that the lateral shoots continue to grow, and the tree becomes more or less distorted.

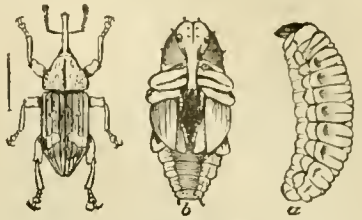


FIG. 11.—*Pissodes strobi*: beetle at left; *a*, larva; *b*, pupa—enlarged about three times (from Packard).

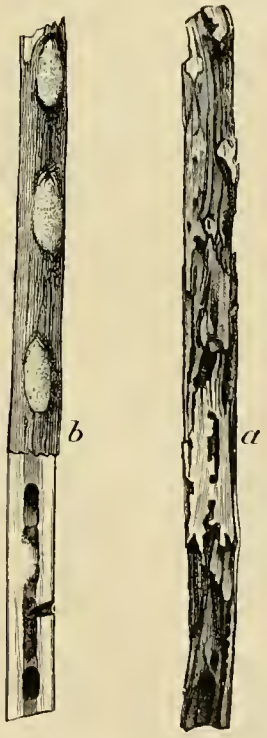


FIG. 12.—*Pissodes strobi*: *a*, larval mines under bark; *b*, pupal cells—natural size (from Riley).

Owners and overseers of pine groves will do well to make a practice of examining the young trees each year, say in August, and when one with a wilting terminal shoot is found to cut or break it off and commit it to the flames. With every blighted twig thus treated from a dozen to fifty or more weevils will be destroyed, and thus the numbers of the insects for the coming year will be greatly lessened. All dead growth or such trees as have from any cause been injured beyond recovery and which might serve as centers of infestation by harboring this weevil or other injurious species should be similarly treated. What is most needed is a preventive, and for this purpose a good thick fish-oil soap mixed with Paris green and carbolic acid, in the proportion of about a pound of the former and a quart of the latter to 100 gallons of the wash, is recommended. It should be sprayed in April and May on the terminal shoots of the trees and repeated at the end of a month if necessary.

MOTH CATERPILLARS AND PLANT-LICE ON TRUNKS AND LIMBS.

The trunks and limbs of pine are also subject to the attack of several insects besides those in the order Coleoptera that have been mentioned. Of these are three tortricid moths of the genus Retinia, which affect the pitch and other pines. Two other moths of similar habits to the above occur on White Pine, wounding the trunk below the insertion of the branches and causing the resinous sap to exude. These are the pitch-drop worm (*Pinipestis zimmermanni* Grote) and *Harmonia pini* Kell.

The same remedies advised for other boring species, and particularly those specified to be used against the white-pine weevil, are indicated for the present class of insects.

Several species of plant-lice affect the White Pine. The white-pine aphis (*Lachnus strobi* Fitch) is very abundant in the Northern States, living in colonies on the branches of trees and puncturing and extracting their juices. The so-called "pine blight," *Chermes pinicorticis* Fitch, is sometimes very destructive, its presence being manifested by large patches of a white, flocculent

secretion, beneath which covering are concealed myriads of minute lice. *Schizoneura pinicola* Thos., feeds on the tender shoots of young White Pine.

Kerosene emulsion applied as a spray is the appropriate remedy for these plant-lice.

LEAF-FEEDING INSECTS.

The most destructive insects of the foliage of pine are several species of sawflies of the genera Lophyrus and Lyda, one of which is represented in its several stages at fig. 13. It is called

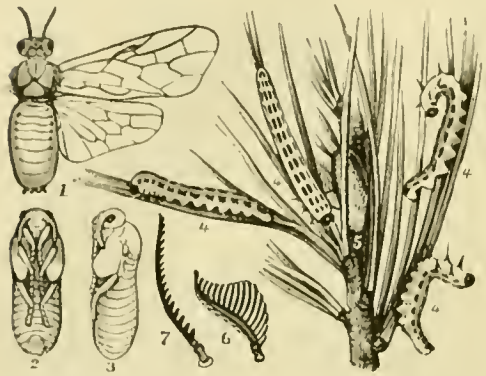


FIG. 13.—*Lophyrus abbotii:* 1 female, enlarged; 2, 3, pupa, enlarged; 4, 4, larvæ, natural size; 5, cocoon, natural size; 6, male antenna, 7, female antenna, enlarged (from Riley).

FIG. 14.—Tubes of pine leaves made by pine tube-builder—natural size (from Packard).

Abbot's white-pine sawfly (*Lophyrus abbotii* Leach.), and is perhaps the most injurious foliage feeder which infests the pine woods of the North.

The caterpillar of a single species of butterfly, *Thecla niphon* Hbn., is known to feed upon the foliage of White Pine, but among the larvæ of moths of different families are innumerable pine-

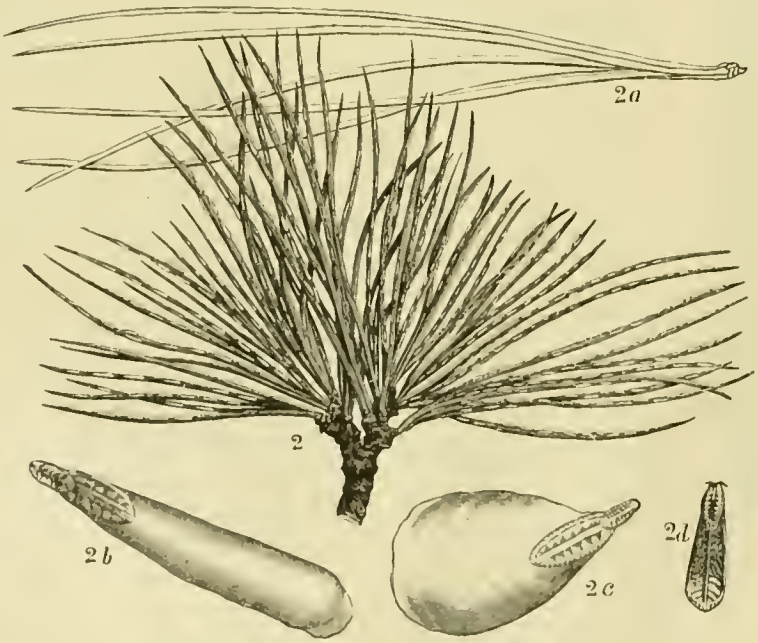


FIG. 15.—*Chionaspis pinifoliæ:* 2, scales on White Pine, leaves stunted; 2*a*, same leaves not stunted by insects; 2*b*, 2*c*, female scale; 2*d*, male scale—2 and 2*a* natural size, 2*b* and 2*c* much enlarged (from Comstock Ann., Rept. Dept. Agr., 1880).

feeding species. Prominent among them is the magnificent sulphur-yellow imperial moth (*Eacles imperialis* Drn.), whose larva attacks the leaves of various forest trees. Of other moths whose caterpillars devour the foliage of White Pine may be mentioned: Harris's pine hawk moth (*Ellema harrisii* Clem.), *E. coniferarum* S. and A., *E. pinetum* Lint., *Tolype laricis* Fitch, the white-pine tufted caterpillar (*Platycerura furcilla* Pack.), the redhead inchworm (*Semiothisa bisignata* Walk.),

the sulphur leaf-roller moth (*Dichelia sulphureana* Clem.), *Teras ferrugana* S. V., and *Amorbia humerosana* Clem. An interesting species is the pine tube-builder (*Lophoderus politana* Haw.), which, in its larval stage, lives within a tube formed by webbing together a number of pine needles as shown in fig. 14.

A number of species of adult Coleoptera, whose larval habits are imperfectly understood, subsist upon the leaves of White Pine. Of these are the Scarabæid, *Dichelonycha albicollis* Burm., and the Chrysomelid, *Glyptoscelis pubescens* Fab.

The best remedy for the sawfly larvæ, caterpillars, and beetles is a spray of Paris green, applied upon the first appearance of these insects on the trees.

The consideration of the insect enemies of the White Pine may conclude with the mention of the pine-leaf scale insect (*Chionaspis pinifoliæ* Fitch), which forms its scales upon the leaves, exhausting them of their juices and causing them to turn yellow. This species is illustrated at fig. 15.

A strong spray of kerosene emulsion will be found an efficient remedy against these scale insects.

FOREST MANAGEMENT.

As regards forest management, we have, unfortunately, in this country no experiences which would permit us to form very positive opinions based on actual observation regarding this species or any other. The study of the natural history of the species in its native occurrence permits us, nevertheless, to draw conclusions which may at least serve as a basis for its future sylvicultural treatment.

In the first place, it may be declared that the White Pine is the most important and promising species upon which to expend attention in our coming forestry operations within the limits of its natural occurrence. Its adaptation to a variety of soils and situations within these limits, its rapid growth, its excellent form, its remarkable mass development per acre, its shade endurance, its all-round useful wood product, and its propagation, both by natural and artificial reproduction, give it a position among our timber trees hardly approached by any other.

There are certain general principles which are the result of experience in forest management in Europe and elsewhere, applying to this as to most species. The first is, that mixed growth is in every respect superior to pure growth; it will therefore be proper policy to grow White Pine preferably, if not altogether, in mixture with other species. This advice is given in spite of the fact that the White Pine grows rather well in pure stand, and that, owing to its shady crown during a long period of its life and the density of stand in which it can develop, and the large quantity of foliage which it sheds, the soil conditions are not in danger of deteriorating, as would be the case with more light-needing species. But, as has been observed in its natural occurrence, its development is more favorable in companionship, and especially is this the case with regard to the cleaning of the bole of its branches, which are peculiarly persistent. Whether it would pay to substitute an artificial cleaning by pruning the young growths is still doubtful; meanwhile the self-pruning performed by mixture with shady companions will have to be encouraged, especially as thereby other valuable advantages are secured which attach to the mixed forest in general.

Unfortunately, our irrational exploitation has reduced the White Pine in the natural forest areas often to such an extent that its reestablishment is possible only by artificial means. Wherever the culling has not been too severe, and either young growth has developed or seedling trees have been left, the natural reproduction should be encouraged by favoring the young growth and by removing or thinning out other species which interfere with the starting of a young growth. Fortunately, the White Pine, owing to its shade endurance, is specially fitted for natural reproduction from the seed of mother trees, more so than most other pines, and the rapidity of its growth, in which it excels most other shade-enduring species, is also favorable in this respect.

We are not yet prepared to determine the most profitable rotation in which the species is to be managed under varying conditions. The fact that it is not only a very rapid but one of the most persistent growers, trees making wood at the rate of 1½ to 2 cubic feet per year up to the one hundred and fortieth year, permits a wide range of choice for rotations, and since its wood, being rapidly changed into heartwood, becomes serviceable very early, the rotations may be either low or high, varying from fifty to one hundred and fifty years, according to local economic and soil conditions.

NATURAL REPRODUCTION

The White Pine reproduces itself readily in the virgin forest on all sandy and loamy sand soils where the hardwoods do not interfere. On these areas thickets of young growth, sapling timber, and dense groves of mature trees are scattered without regularity, and there is no indication that this pine forest has undergone material change for centuries. In the hardwood districts of the heavier soils of the Lake region, where the pine is met with chiefly as old, overripe timber, the reproduction of the pine seems, temporarily at least, to be interfered with by the associated growth. Large, old trees occur, thinly scattered or in clusters, but sapling timber and young growth is often entirely wanting over considerable areas. Similar conditions prevail, or have prevailed, in the mountains of Pennsylvania, and also in New England and in the Adirondacks. Where the pine is cut and some seed trees are left the ground soon covers itself with young growth. This, contrary to the common notion, is true even where fire has run over the slashings and the ground for a time is stocked with Poplar and other brush. Such groves or thickets of young pine occur in all parts of the pinery of the Lake region, and in the aggregate cover several hundred thousand acres. Generally, however, the fire returns from time to time, the young seedlings, as well as the mother trees, are finally all destroyed, and thus the reproduction is completely prevented. On such lands, impoverished by fire and exposure to sun and wind, not even the Poplar returns. In the hardwood, Spruce, and Hemlock regions the cutting of the pine in the usual manner simply assists its competitors, and its reproduction is seriously hampered and frequently prevented altogether. Where these clay and loam lands are completely cleared and then abandoned, as has been the case with thousands of acres of New England forests, the White Pine is one of the first to return if any seed trees exist in the vicinity. Hundreds of groves have sprung up in New England in this way.

NOTES ON NATURAL REPRODUCTION.

A case of the kind above referred to was observed in 1886 in York County, Me., and the following notes on the subject will, no doubt, prove of interest:

In company with Mr. John E. Hobbs, who is thoroughly familiar with the history of the various pieces of forest examined, a visit was made to a number of places on which White Pine was growing, others on which young pine seedlings were coming in, and still others in the immediate vicinity where none were to be seen, although the general conditions of soil and situation were practically identical. The soil, much of it, was light and sandy, with a growth of *Comptonia, Pteris, Gaultheria,* and other plants common on pine land.

A large number of trees had a crop of cones, the last year before this visit in which there was a good crop having been 1879, according to Mr. Hobbs. Going first to an open field that was formerly covered with pine trees, it was found to be very thickly covered with young seedlings, from a few inches to 2 feet or more in height, that had sprung up in such abundance that a bare spot was hardly to be seen over the whole tract. This piece was cut over in the winter of 1879-80, the ground was not burned over, and there being a good crop of seeds, these had grown promptly and a young forest was rapidly coming on to take the place of the one removed.

On going to other pieces in the vicinity, from which the pine had been cut at different times since 1879, a most striking contrast was observed. On these pieces that seemed otherwise just like the first, and with the conditions just as favorable for a second growth, only a very few pine seedlings were to be seen. These few may have come from seeds carried by wind from the neighboring forests, but evidently the ground had not been seeded as the first piece had, and it was impossible not to draw the conclusion that the difference was due simply to the fact that the first piece was fully seeded, while the others were not. Repeated observations of similar pieces of land led further to the conclusion that no dependence can be placed upon the springing up of seeds that have lain dormant in the ground for a term of years; or, in other words, although the seeds of the White Pine retain their vitality for a long time if kept in a dry place, there is a lack of evidence to show that this is the case in the natural forest, where they are alternately dry and wet.

Other interesting conditions of growth were noticed in the same region. In the vicinity of standing pine forests, particularly on their leeward side, seedlings of different ages were coming up, often very thickly, but upon entering the forest, after the first 2 or 3 rods, no more of these were to be seen, their growth having evidently been prevented by the dense shade of the standing trees. In hardwoods, on the other hand, where the surroundings were a little more favorable, some young pines were growing here and there.

All observations reenforced the truth that there is no mysterious succession of forest growth, involving necessary alternations, and that the White Pine does actually grow and flourish for an indefinite number of generations on the same land, if only the necessary seeding has been insured.

In such regions as have just been described reforesting with the White Pine is a comparatively simple matter. Where nothing more is done than to take advantage of natural conditions by felling the trees in seed years, or by leaving seed trees here and there, an abundant crop of young pines may often be secured. As a matter of fact, large

tracts in Maine and Massachusetts are coming up in this way to second-growth pine, and as the profit arising from the protection of these young forests is better understood, there is no reason to doubt that the whole matter will in a great measure regulate itself.

In the Adirondack region and in the pine belt of Michigan, Wisconsin, and Minnesota the case is far different. Under the present system forest fires are an almost necessary result of all lumbering operations. To start with, all trees that are large enough are cut, and if by chance here and there one has escaped that might produce a crop of seeds, it perishes in the fires that soon sweep over the ground, leaving hardly a living thing behind them, and burning the seeds that under other conditions might have sprung up to form a second growth of pine. On all such burned tracts pine seedlings are rarely found in any number, and yet here and there they are seen growing where the fire had left a seed tree by the side of a stream or a piece of unburned ground, thus giving the seed a chance to grow.

After making a careful study of the pine lands of Michigan for several years the conclusion seems plain that here, exactly as in New England, everything practically depends upon reseeding. Here in the Northwest the seed trees have been destroyed, the seeds in the ground have been burned, and, as an inevitable consequence, the land remains a wilderness and must remain so until some means are found of restoring the forests by artificial sowing or planting. There is nothing in the soil itself that prevents reforesting the pine lands of Michigan at once. It is because seeds are, to a great extent, wanting, and the seedlings that do start are not protected, that these pine lands are left in their desolate and unproductive condition.[1]

The experience with White Pine in Europe fully confirms the correctness of the observations above recited. White Pine abroad reproduces well, seeds abundantly, and is so particularly well suited to natural reproduction that the most experienced and competent recent writers claim that this tree fairly "demands" this form of regeneration.

ARTIFICIAL REPRODUCTION.

Concerning the artificial reproduction by seeding or planting, the experience, both in this country and Europe, is quite extensive. Not only has this species been planted frequently and for a long time in New England and in other parts of its natural range, even for forest purposes, but thrifty groves have been established also in the Western prairies beyond the limits of natural distribution. In Germany larger or smaller plantations were made in many localities near the beginning of the century.

The planting in this country has, however, not usually proceeded with a knowledge of proper forestry practice. As a rule, plants have been set out too old, and hence the planting has proved expensive; usually, also, it has been too wide spaced to secure the most desirable result in form development. Another point also usually neglected is the admixture of other species to stimulate the growth of the pines and possibly to reduce the expense of covering the ground.

In Europe the majority of pine plantations made with Scotch Pine (*Pinus silvestris*) is made with one-year-old seedlings, which is done very cheaply and expeditiously, often on unprepared ground, when one man may set 1,000 to 1,500 plants in a day.

For White Pine, especially under our conditions, where the young plants have much to contend with in the way of climatic ills, weed growth, etc., this method is probably not applicable.

Two-year and even three-year old plants, grown in seed beds and once transplanted in nursery rows, to produce a stocky root system and growth, will probably be more successful, being better prepared to overcome adversities.

The seedlings, grown from seed sown either broadcast or in drills in the seed beds, must be shaded during the first two years, as is usual with conifers in this country. After the second year they will endure the hottest sun. The shade must be graduated according to the weather, as the seedlings are liable to damp off the first season if too much shaded and to burn off if not shaded enough.

As there are about 1,800 seeds to the ounce, it will take about 5 to 6 ounces to the 100 feet of drill, unless the seed be specially poor, when greater allowance will have to be made in proportion

[1] We are likely to repeat in the Northwest, on an extensive scale, the history of several of the Eastern States. Under inducements held out to encourage immigration, many settlers have been led to take up land all through the worst part of Michigan and Wisconsin, including the "barrens." They clear the land, seed it, if they can, with clover, and put in other crops, work in the adjacent pine woods for a living, and "develop the country," thus doing for the State exactly what needs to be done and what the State has neglected to do for itself; but it is a disastrous experiment for the settlers. The many farms kept up in this way for a while may finally be abandoned, but the whole region will then be in a great measure secured against extensive fires, and the lands that have been plowed and worked over will be in a better condition for reforesting.

to the percentage of germination. In ordinary collecting the percentage of germinating seeds may not exceed 75 per cent, and, as is indicated in the discussion on seed supply (page 23), it may fall far below this figure in some years. Even if 20,000 to 25,000 seeds should germinate per pound, it would not be safe to count on more than 5,000 to 8,000 seedlings that will grow to use, and in the transplanting to nursery rows an allowance of at least 5 to 10 per cent should be made for losses, so that to secure 10,000 transplants at least 1½ pounds of seed is needed, to secure which it may take from 3 to 4 bushels of cones.

Close planting is indicated on account of the difficulty with which this pine cleans itself of its branches. It should be planted not more than 4 feet apart or, preferably, set out in mixture with a shady, slower growing companion, the Black Spruce (*Picea nigra*) being an ideal choice within its habitat, and of broad-leafed trees the Sugar Maple (*Acer saccharinum*), which, for the sake of economy, may be sown between the wider spaced (8 feet or more) plants of White Pine. The mixture should not stop here, but other kinds chosen with circumspection from the many that are found associated with the White Pine in its natural habitat should be added, as Chestnut, Yellow, and Red Birch, Basswood, Hickories, and Oaks, and of conifers, the Red Pine, Hemlock, and occasionally in some localities Arborvitæ.

Dr. Fernow has for some time (since 1887) advocated a method of forest planting in which the main or "final harvest crop" is distinguished from the mere "nurse crop" or "filler," when only 500 or 600 trees per acre, or even less, of the better kinds are set out with care as the main crop, receiving due attention in their further development, and the nurse crop is introduced of the cheapest kinds and in the cheapest manner to act as soil cover to check weed growth and stimulate height growth, straight form, and cleaning of the main crop. The White Pine would, of course, be a most excellent main crop.

By the fiftieth year or so the pines, if set out at the rate of 500, will have overtopped the nurse crop, except where trees of the latter have taken the place of a failing pine, and their crowns will have closed up, their boles straight and clean, furnishing clear lumber, if the nurse crop was properly chosen and has done its duty. The further management then would concern itself mostly with gradual thinning out of the main crop to secure the diameter accretion due to increased crown development and light. By the one hundredth year it will be reasonable to expect at least half the trees set out to have reached their highest value in maturity and size, with 15,000 to 20,000 cubic feet to the acre, for the White Pine is not only a rapid grower, but a large producer, its shade endurance permitting as large a number of trees to develop satisfactorily per acre as the Spruce, which it outgrows in height and diameter.

While planting nursery-grown seedlings as a rule furnishes better results, sowing the seeds into permanent sites may, under certain conditions, especially on soils not too prone to weed growth and in the more humid climate of the Northeastern States, prove satisfactory and cheaper.

Various methods can be employed according to circumstances. On light soils sowing broadcast on snow may furnish satisfactory results; on heavier soils preparation of the ground to receive the seed will prove indispensable. This may be done by plowing furrows or by hoeing plats of 2 or 3 feet square (the larger size where overgrowing by brushwood is to be feared) and sowing into these in drills or broadcast. Dr. Fernow devised such a method for reclothing cut-over lands on slopes in Pennsylvania grown up with brush, where it would be too expensive to prepare the entire ground. Here the plats were made larger, 4 or even 6 feet square, and into these not only pines were either planted or sown but also a nurse crop surrounding the pines, expectation being that this nurse crop will protect the pines against the encroachment of the surrounding brush growth until the pines are tall enough to fight their own battle and finally kill out the brush. A fuller description of these plantings is to be found in Bulletin 17, "Check list of the forest trees of the United States," etc., of the Division of Forestry.

PLANTING NOTES.

The following notes on planted groves, their condition, growth, and results are given a place here as recording individual experiences in various parts of the country, without intending to recommend the practices of the planters, which, from the forester's point of view, are faulty in some directions, especially in the open stand, which is advocated:

In Eastern Massachusetts, particularly in Plymouth and Bristol counties, there are numerous small bodies of White Pine that were set out from forty to fifty years ago, and whose rapid growth and healthy conditions show that

there the work of planting at least has been successful. The trees composing them averaged at thirty to thirty-five years from the time of planting, not far from 45 feet in height, and measured approximately 2 feet 6 inches in circumference, breast high. These measurements vary for different bodies of pine, but are believed to represent very closely the average size at the age indicated, and in many cases the trees are considerably larger (see measurements of growth on page 88). This growth of pine is of such value that according to competent judges of property in that region, much of the land that without the pine would be worth only $3 to $10 per acre, is worth with the standing pine $50 to $75 or more per acre according to location.

Upon visiting these different groves and conversing with men who had planted some of them, it was found that opinions and practice were quite variable, both as to time and manner of planting. Mr. S. E. Hall, of Raynham, who has had long experience, states that he has set the White Pine successfully every month in the year. The young trees, 4 to 6 inches, or even a foot high, are taken up with a piece of sod on their roots and set out in a wet time. These two conditions were particularly emphasized by Mr. Hall, who says that if they are observed the trees "will grow anywhere." He plants 10 feet apart each way and recommends this as the best distance, which is, however, not good forestry practice. In a grove set by him forty years ago the trees were set in rows at the above distance and had made a vigorous and healthy growth. In another grove, planted about the same time, the trees stood 8 feet apart each way and were apparently doing quite as well as in the first one. On the other hand, Mr. Spencer Leonard, of Bridgewater, after many years of practical trial and observation, states that having formerly set out pine trees 10 feet apart, he is now setting them at a distance of 15 feet, with a view to reduce the expense of planting and because they soon became crowded if planted closer. He, too, sets out the trees with a sod, simply plowing a furrow and setting the seedlings at the right distance. Mr. Hall digs a hole for each tree, but says that the work can be done very rapidly, and that he has himself set an acre a day.

One of the many plantations in southeastern Massachusetts known as "Leb. Pratt's grove," is within less than a mile of the village of North Middleboro. It was set out forty-two years ago. The trees were set in rows 10 feet apart each way. The grove twelve years ago even was practically impenetrable by reason of the dead interlocking branches that had never been removed.

Four trees of average size were measured in 1886 and showed diameters of 7 to 9 inches. Some were of larger and others of smaller size, though the growth was fairly even. The average height was estimated at 40 feet; the branches were dead three-quarters of the way to the top, the remaining one-fourth, say 10 feet, constituting the crown, was green and healthy. The soil was poor, that passed over from the road in reaching the grove being light sand with some gravel.

Another grove, some 3 miles northward of North Middleboro, was visited in 1886, and a greater number of measurements made. According to Mr. S. Hayward, near whose farm it stands, this grove was set out rather more than thirty, not more than thirty-five, years ago, but had not made quite as good a growth as some others have. The trees are in rows, 7½ to 8 feet apart each way, and are quite uniform in size. Beginning with the third from the north side, a fair average row, the following measurements were made of the trees taken in order as they stood. The circumference, breast high, was:

	Ft.	Ins.		Ft.	Ins.
No. 1	2	10	No. 7	2	6
No. 2	2	6½	No. 8	2	11
No. 3	2	9	No. 9	2	10
No. 4	2	4½	No. 10*a*	1	5
No. 5	2	6		0	10
No. 6	2	1	No. 11	2	0

a Two main stems and had lost a third.

The largest tree measured in the grove was 3 feet 1 inch in circumference or 1 foot in diameter, breast high. A very few have been choked out and have died after living fifteen or twenty years. An average tree on the south side measured 45 feet in height. All the trees of the grove that were still living seemed healthy and vigorous. The lower branches had died at an earlier age than in the preceding grove and the trunks were free from them for some 8 feet or more. Above this line the dead branches still remained on the trees, only those of the crowns being green and living.

Near Bridgewater, Mass., a piece of land had been sown with pine seeds some thirty-five years before, the seeds being sown broadcast and dragged in. The trees were slender and too much crowded, the smallest ones dying out. They seemed much in need of proper thinning. Some of the best specimens measured 2 feet 7 inches in circumference, breast high, but they were very uneven in size, and did not impress one nearly as favorably as those in the groves that had been regularly planted at a distance of 8 or 10 feet apart.

This second growth pine finds a ready market at the box factories of Bridgewater, Halifax, Taunton, and various other towns in this part of the State. Six dollars per cord is the price paid at present (1886; now $8 to $9) for logs delivered at the factory. Logs are accepted down to 8 inches in diameter, and in establishments where staves are made a smaller size is taken. There is no trouble in obtaining all that is wanted, there being an abundant supply of pine for box boards, staves, and the like in the immediate vicinity of the towns where they are manufactured.

A few notes on plantations made on the Western border and outside of the natural range of the White Pine will show the adaptability of the species in those regions:

There is an instructive plat of White Pines in the forest plantation of the State University of Illinois. This institution is located at Champaign, about 200 miles south of Chicago and much beyond the natural range of the

pine. The history of the plat, as given in Bulletin No. 26 of the University Agricultural Experiment Station, is as follows:

White Pine seedlings were collected in the spring of 1869, put in close nursery rows and shaded with lath frames. About 8 per cent died the first year. Of a few hundred trees, purposely left without shading, 32 per cent died. After having grown in the nursery three years, they were deemed in good condition for transplanting. They were at this time 12 to 15 inches high, well-formed, healthy trees.

The land, 1 acre, where the White Pines are planted, is quite flat, what slope there is being to the south; and at least one-half of it is too wet in spring, and often in the early part of summer, for the best results in tillage. The soil is black, part of it mucky, 1 to 2 feet in depth, and underlaid, for the most part, with a rather stiff, blue clay. The trees were planted May 4, 1872, 4 feet apart each way. The White Pine is a comparatively hard tree to transplant successfully (?). The roots are soft, long and naked, with very few small or fibrous roots near the tree. Knowing the necessity of careful handling, no effort was spared, from digging in the nursery to setting in permanent place, to secure successful results.

Throughout the season the ground was kept in a good state of tillage by frequent cultivation, but it was exceedingly dry; and of nearly three thousand trees planted, two-thirds died during the summer. Of Norway Spruce, planted the same day, in the same manner, and on very similar soil, not more than 2 per cent died. It is difficult to explain this greater per cent of loss in the pines, except as we take into account the comparative method of development of the roots of the two species [and its high transpiration factor.—B. E. F.].

In the spring of 1873 the vacant spaces were filled from the nursery, and again in 1874 trees were set where needed. The result of the three plantings was an almost perfect stand of trees. The cultivation with horse and hoe was kept up thoroughly for three years. During the fourth, fifth, and sixth years the weeds were mowed. But little cultivating was done, because the ground was too wet in the early part of the season.

For a number of years after the White Pines were fairly started they made admirable growth, and promised to furnish very valuable timber for the prairie soil here, as well as for their native regions. In a report made in 1886 the following statement is made: "From the first the living trees have done exceedingly well. Very few trees have died from any cause since they began their growth in their present position. They are now remarkably healthy and vigorous, and the plantation vies with that of the European Larch in beauty and prospective value." At present they are not maintaining the early promise.

No thinning or pruning of any kind was done, except what nature does, until the winter of 1889–90. During that winter and the next the dead branches, to an average height of about 10 feet, were trimmed off, and the dead trees (some more than three hundred and fifty) were cut out. During the winter of 1891–92 sixty-eight more dead trees were cut out, and there are at present fifty-two still standing that have died since the last were cut. The trees cut out the first time had not all died recently. Some of them gave evidence of having been dead for a number of years, while others had died so lately that they still carried dead leaves. Most of the trees that have died were the smaller ones, such as were overgrown or badly crowded. A few only of the larger trees have died. Of the trees still alive, very few have any live branches lower than 20 feet. Many of them have an unthrifty look, either in the top or on the trunk, and the prospect is that there will be a very considerable number of trees to cut out year by year for some time.

The principal reason for so many trees dying is probably overcrowding [more likely owing to the stiff subsoil.—B. E. F.]. As the trees now stand they occupy a space of less than 7 feet square each. The trees have been damaged in other ways than crowding, but not, so far as can be judged, until after they had already begun to die. There is continually a thick mat of leaves on the ground, and these have been partially burned off twice, both times injuring the trees more or less from the ground up 2 or 3 feet, but apparently not any higher. Boys seem to delight to cut their names or designs in the smooth bark of the trees. Occasionally a tree is entirely girdled. The girdling soon kills the trees, but most of the smaller damage to bark soon grows over. A woolly plant louse (*Chermes pinicorticis* Fitch) has been very abundant on many of the trees, attacking the trunks and larger branches for several years. They are sometimes so abundant that the whole trunk has from a little distance a white or grayish-white appearance.

The White Pines do not cast so dense a shade now as they did ten years ago. At that time there was no undergrowth among them. At present there are small wooded plants, such as Grape, Raspberry, Cherry, Box Elder, etc., besides weeds, coming in, and there would likely be more of these were it not for the heavy mulch of leaves that covers the ground.

In 1886 the average size of the better trees was: Height, 24 feet 9 inches, and a little less than 6 inches in diameter. At present, 1895, the better trees are 38 to 40 feet high, and 8 to 9 inches in diameter. During the winter of 1882–83 the leaders of a considerable proportion of the trees were broken down by the weight of sleet. This was the cause of many trees being crooked at that point, and of others having more than one leader. Except for the trees deformed in this way nearly all have almost perfectly straight trunks. The trees are much more nearly uniform in height than in diameter. The sizes of the trees in the plat are as follows: Fifty-eight are 3 inches in diameter; one hundred and ninety-four, 4 inches; two hundred and fifty-six, 5 inches; two hundred and thirty-six, 6 inches; one hundred and forty-four, 7 inches; seventy, 8 inches; eleven, 9 inches; five, 10 inches.

In the autumn of 1895 the thirty-nine trees constituting the central row of the plantation were measured, and the average diameter, breast high, was 5.9 inches, the range being from 4.1 inches to 8.6 inches.

At the old Elgin nurseries, planted in open prairie about 1½ miles west of the Fox River, black loam soil, from 4 to 5 feet to gravel, White Pines, forty to forty-five years old, with Norway Spruce and Scotch Pine as neighbors, measure 22 inches in diameter, breast high, and are 52 feet high. In a neighboring grove, twenty-five years from seed, planted exclusively to White Pine, the trees average 11 inches in diameter and 45 feet high. When planted alternately with European Larch 5 to 6 feet apart, the White Pines, thirty-five to thirty-six years old, are perfectly straight and average 13 inches in diameter and 75 feet in height. The European Larch proves to be the best tree to plant with White Pine as a nurse. When planted with Box Elder and Ash the growth of the pines is not so satisfactory. Where Scotch Pine has been planted alternately with White Pine the latter has outgrown the Scotch, nearly all of which are killed out. In the groves where Larch is planted with White Pine the ground is completely mulched from the foliage of the Larch; drought has never affected the trees, and no grass or weeds can grow among them.

Mr. Thomas Hunt, of Ridott, Ill., set out White Pine in a plantation of 10 acres twenty-two years ago. The trees were 10 to 18 inches high when set, making their age at time of measurement about twenty-seven years.

The grove is planted on a ridge with thin clay loam underlaid with broken laminated limestone. Mr. Hunt found the land unprofitable under tillage after several years' trial. The trees of each variety are planted in solid rows, hardwoods and conifers alternating. In a plat of White and Scotch Pine, Norway Spruce, Arborvitæ, European Larch, White Elm, Box Elder, Green Ash, and Willow, the conifers have almost shaded out the hardwoods. The

Larch are the tallest and the Arborvitæ the lowest, the remaining conifers being of about equal height, averaging 35 feet. Seventy White Pines were measured, taking all the trees as they came in the rows, and including the center of the plantation. The average diameter, breast high, was 6.2 inches. The branches were dead, but still persistent to a height of 18 to 20 feet.

At the Bryant nurseries, Princeton, Ill., somewhat south of the natural limit of the White Pine, trees that were grown as ornamental nursery stock have been permitted to stand, giving some notion of the growth of the species in the rich prairie loam of that region. The oldest specimens were set in 1858 and were imported seedlings. They are now about forty-two years of age, and average about 65 feet in height. Measured trees range from 9 inches to 26 inches in diameter. Norway Spruce of the same planting equal the pines in height, but the average diameter is less. These trees stand about 30 feet apart. On the margin of a natural hardwood grove an acre of the richest prairie land was planted to White and Scotch Pine seedlings about twenty-two years ago. The trees were set 3 by 4 feet, and have never been thinned. Each species was planted pure, and one of the tallest White Pines measured 33 feet high, the average height being estimated at 26 feet. Fifty White Pines, taken as they came in the rows, were measured, breast high, the average diameter being 4⅛ inches. Scotch Pine showed about equal growth.

At the Iowa Agricultural College, Ames, Iowa, in the center county of the State, a piece of waste land of about 3 acres was planted to White Pine, European Larch, Box Elder, Green Ash, and Cottonwood in 1875. The plat occupies a gravelly knoll sloping to the north. The soil is a yellow clay, with much gravel, and of unknown depth. The top of the knoll forming the south side of the plantation is set with pure Larch. The Pine, Box Elder, and Ash are mixed, evidently without order. The original planting was 3½ by 3½ feet apart, and the trees now average about 10 feet apart each way. The White Pines are estimated to average 30 feet high, and twenty-six measured trees, taken as they came, ranged from 5 to 14 inches in diameter, the average being 8.7 inches. The pines are now the dominant trees of the mixture and are fully 10 feet higher than the Box Elder, which exceed the Ash 5 feet. The following diameter measurements will serve as an additional basis of comparison:

	Inches.
White Pine, as above (26 trees)	8.7
Box Elder, as above (23 trees)	4.7
Green Ash, as above (21 trees)	3.6
European Larch (planted pure on crest, 26 trees)	6
Cottonwood (same plat, base of knoll, 14 trees)	10.5

It should be added that the Cottonwoods stand wider apart than the mixture of Pine, Box Elder, and Ash, while the Larch stand closer together. All were set originally 3½ by 3½ feet, and the alternate rows have been removed throughout the plantation.

At Windom, Minn., in the southwest part of the State, Mr. E. Sevatson has included two rows of White Pine in a plantation covering 10 acres. These trees were set about thirteen years ago, when 8 to 12 inches high, and are presumably not over eighteen years old. The two rows of pine are between rows of Arborvitæ and Balsam Fir. They are about 25 feet in height, and the average diameter, breast high, of seventeen trees, taken as they came in the rows, was 5 inches. The soil is a stiff clay loam, and the plantation is about 100 feet above the surface of a lake which joins the farm. The entire country is treeless, except for groups of trees on the lake shore and groves along the Des Moines River, 3 miles distant. The White Pine in this location is less vigorous than Scotch Pine, European Larch, or Norway Spruce.

Fine trees of White Pine, set in single specimens about thirty years ago, are growing at Arbor Lodge, Nebraska City, Nebr., the home of Hon. J. Sterling Morton, ex-Secretary of Agriculture. These stand in bluff soil (a fine loam) about 2 miles west of the Missouri River. A few fine specimens may also be seen in the lawn at the homestead of Hon. A. H. Whiting, at Whiting, Monona County, Iowa, in the deep black loam of the Missouri bottoms. At Brookings, S. Dak., within 17 miles of the Minnesota line, repeated plantings of the White Pine have resulted in failure. At Franklin, Nebr., about halfway across the State, near the Kansas line, this species has failed after extended trial. Very few trees can be seen in Lincoln, Nebr., though it has been repeatedly tested there as an ornamental tree. The diminished amount of atmospheric moisture will necessarily prevent general satisfactory cultivation beyond the western boundary of Missouri, Iowa, and Minnesota.

A number of fine specimens of White Pine stand in the lawn of the Rollins homestead at Columbia, Mo., about 10 miles north of the Missouri River and halfway between the east and west boundaries of the State. The soil is a clay loam, underlaid with limestone, which outcrops at many places in the vicinity. These trees were planted in 1855, when two or three years old, by Col. J. H. Rollins. The largest is now (1897) 29 inches in diameter, breast high, and 64 feet 9 inches in height. One of the smallest is about 56 feet high and 16 inches in diameter.

Additional notes of plantations in the West might be given, but the above is sufficient to show the White Pine can be successfully grown somewhat beyond its natural range, but does not well endure the dry conditions of soil and atmosphere which it must meet in the region west of the Missouri River.

THE WHITE PINE AS A FOREST TREE IN GERMANY.

As has been stated, the White Pine was introduced quite early into England, and from there it found its way into various parts of the Continent. In England it remained largely a park tree. In Germany it has been a forest tree proper for over a century, being used quite frequently, on account of its hardiness and shade endurance, as "gap cover" to fill fail places. It has also been planted in many places on small areas as pure growth or mixture with the common European or Scotch Pine (*Pinus silvestris*) and Spruce. For a long time this "newcomer" was regarded with a

feeling of doubt and even suspicion, and long before anything definite could possibly be said about the matter the merits and faults of the White Pine were extensively discussed. The "practical" man, and with him some scientific men, were satisfied that such a light-colored softwood could not possibly be durable or otherwise desirable, and the small quantities offered from time to time did not always find ready market. Of late years this condition has changed. In a series of excellent articles, Dr. L. Wappes, a Bavarian forester, records the experience had in one of the oldest bodies of White Pine in Germany, in which he shows that the tree in pure growth, and also as mixture with pine, spruce, or hardwoods, has proven a most excellent factor of the German forest; that it seeds early and heavily, and as plant material is easily and cheaply secured; that it is readily and even preferably reproduced by natural seeding, a rapid grower, capable to withstand crowding and shading, and that it is a tree especially capable of producing a large amount of timber even on poor soils, all of which coincides with the observations on its native habitat laid down in this monograph. He shows that besides the Fir (Balsam), the White Pine is the only tree which, in the Palatinate and on poor soils will, at the age of one hundred and ten years, make timber of Class I (according to German notation, diameter at half length, 22 inches and better); that while the common pine at that age furnishes only 13 per cent of Class III and better (diameter 12 inches and over), the White Pine furnishes 27 per cent, or more than double this amount of these and more valuable diameter classes. Dr. Wappes emphatically states that White Pine, wherever known, is eagerly bought, and that the opinion of the consumers has radically changed. He proves by the figures of large sales from the State forests, that since 1882 the value of White Pine has nearly doubled, while that of Spruce and common Scotch Pine has increased by only 20 per cent, and that of Fir and Larch has actually declined during this period. The following figures give an idea of the growth of White Pine abroad. The groves of the Palatinate are stocked on very inferior soil, nearly all other groves cited being on loamy sand. The figures for total volume are somewhat misleading, since they do not include the timber which has been removed from the older groves in thinnings, which would add probably from 10 to 15 per cent to make up whole production.

It will be of interest to give more in detail the conditions of the last-mentioned plantation, reported this year in Dr. Lorey's Allgemeine Forst und Jagdzeitung:

The plantation of about 9 acres, on fresh loamy sand, situated at an elevation of 2,200 feet above sea level in Wurtemberg, consists of White Pine mixed with Scotch Pine, Spruce, and Fir in single individuals or groups. The White Pine represents, numerically, two-thirds of the total number, Scotch Pine is found among the dominant growth in part, but the Spruce and the small number of Firs show only codominant and oppressed trees.

The density of the growth was reported as satisfactory until in 1875, when a snowstorm broke down much material, so that at present the density does not average over 0.7.

The stand, originating from seed, was several times thinned, and the last time, occasioned by the snowstorm, 400 White Pines were removed, with over 10,000 cubic feet of wood. The number of trees averaged 183 per acre, of which 142 White Pines, with diameters varying from 7 to 24 inches, and 16 inches in the average, yielded altogether 9,510 cubic feet, while the other species added only 1,290 cubic feet. Comparison with the other acre yields recorded shows that under these conditions the product was less than in more favored situations, either the site or light conditions reducing the growth.

The diameters represented on a sample area were distributed as follows:

Diameters ..... inches..	8 to 10	10 to 12	12 to 14	14 to 16	16 to 18	18 to 20	20 to 22	22 to 24
Number of trees	7	20	24	30	33	23	4	1

Of the Scotch Pines only four had reached diameters over 16 inches, and of the Spruces none over 14 inches. The superiority of the White Pine also appears from the comparison of height growth, which was established for every five years by the measurement of average sample trees, as follows:

Height growth of White Pine, Scotch Pine, and Spruce, by years.

Sample trees.	Age (years) and height growth (in feet).																
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
White Pine height growth	2.1	9	18	29	38	45	52	59	65	71	76	81	85	89	92	95	97	100
Scotch Pine height growth	1	12	20	29	35	42	49	54	60	65	69	73	77	80	82	84	87	88
Spruce height growth	2	8	16	24	35	42	48	54	59	63	68	72	75	78	80	82	84	86

The preceding table shows how the slow growth of the first five years which the White Pine has in common with the Norway Spruce is overcome before the fifteenth year, and by the twentieth year the White Pine has distanced the Scotch Pine, gaining on it constantly until, by the ninetieth year, it has outgrown it 12 per cent.

Dimensions and yields of White Pine in German forests.

Locality.	Character of forest.	Age.	Number of trees per acre.	Average diameter (without bark).	Height.	Volume of wood, exclusive of limbs and stumps.
		Years.		*Inches.*	*Feet.*	*Cubic feet.*
Palatinate I	Pure growth	104	250	15.6	92	13,300
Palatinate II	do	68	660	9.1	66	10,000
Palatinate III	White Pine with Spruce	68	550	10.4	79	12,000
Palatinate IV	White Pine and Scotch Pine	58	330	10.3	64	6,000
Palatinate V	do	46	600	7.4	49	4,000
Palatinate VI	do	25	2,200	4	34	3,200
Prussia (Grafinrode)	White Pine mixed with Scotch Pine and Spruce.	(75 to 80)	452	(6 to 28)	(72 to 87)	13,224
Do	Pure growth	(75 to 80)	410	(8 to 18)	(80 to 87)	13,000
Prussia (Rogelwitz)	do	95	333	15	88	14,298
Frankfort on the Main	do	82	723	9.7	72	12,024
Thuringia	do	78	415	11.7	(79 to 89)	13,027
Wurtemberg	White Pine mixed with Scotch Pine, Spruce, and Fir.	93	183	16	98	10,800

From these figures the capacity of the White Pine to produce large amounts of valuable stemwood is apparent. Thus, on soil on which the 100-year-old trees developed only a height of 92 feet, over 13,000 cubic feet of stemwood, corresponding to about 60,000 to 70,000 feet B. M., American scale, were cut per acre over and above about 1,200 cubic feet of material removed in previous thinnings. In every case the White Pine excels the common pine, and even the Spruce in this respect. It should be added that most of these plantations, made in the early part of this century, were not executed according to present superior methods, the species being an exotic and expensive was set out more in orchard fashion, as most planters in our country have been apt to do, at distances of 8, 12, and more feet apart. Owing to this fact the development was probably not as satisfactory in the earlier years as it might have been had the method of close planting, either pure or in mixture, prevailed.

The superiority of growth over the German Spruce and Pine is more fully illustrated in the following table, which shows the distribution and proportion of trees of White Pine and Spruce and of White Pine and Scotch Pine that are found in given diameter classes in two mixed planted growths of these species:

Distribution and proportion of White Pine and Spruce and White Pine and Scotch Pine.

White Pine and Norway Spruce, sixty-eight years old. [65 per cent Pine; 35 per cent Spruce.]			White Pine and Scotch Pine, fifty-eight years old. [50 per cent of each.]		
Diameter of trees.	White Pine.	Norway Spruce.	Diameter of trees.	White Pine.	Scotch Pine.
Inches.	*Per cent.*	*Per cent.*	*Inches.*	*Per cent.*	*Per cent.*
4 to 6	0	9.5	4 to 6	1	2.4
6 to 8	15	30	6 to 8	19.5	32
8 to 10	30	27	8 to 10	18.7	35
10 to 12	22	26	10 to 12	26	24
12 to 14	20.5	6.8	12 to 14	23.5	4.9
14 to 16	10.5	.....	14 to 16	8	1.6
16 to 18	1.5	.....	16 to 18	2.4	.....
			18 to 20	1	.....

It appears that nearly 32 per cent of the White Pine is over 12 inches in diameter, as against less than 7 per cent of the Spruce, while 35 per cent of White Pine, as against 6.5 per cent of Scotch Pine, developed over 12 inches in the mixture of these two, and over 11 per cent of the former belongs to sizes above 14 inches, which is hardly reached at that age by its competitor. These figures prove clearly that the White Pine excels the Scotch Pine even during the age of

most rapid growth, so that the difference, in view of the steady growth of White Pine and the marked decrease in rate of growth in the Scotch Pine, would be markedly greater if older timber had been compared.

Just as in its native range, the White Pine is decidedly a heart pine, the sapwood changing early into the durable and more valuable heartwood. In timber one hundred years old grown in the Palatinate the sap in many cases is less than 1 inch thick, so that 75 per cent and more of the entire stem is composed of heartwood.

In view of these facts it is quite safe to say that the White Pine in the future will be one of the prominent forest trees of Germany, and perhaps of Europe, as it will always be the king of woods in our Northern and Eastern States.

THE WOOD OF THE WHITE PINE.

THE WOOD OF THE WHITE PINE.

By Filibert Roth, *Division of Forestry.*

White Pine is a favorite material with the wood consumer in the Northeastern States on account of the combination of qualities it possesses. It is a light, soft, uniform, straight-grained timber, to be had in all markets in any quantity and in all dimensions, from the ship's mast to the clapboard. It seasons well, shrinks and warps but little, is quite durable, insect-proof, and takes oil and paint and has a good color, is light to handle, easy to saw and plane, takes nails without splitting, and is, in short, the ideal material for the carpenter and joiner, who handles the bulk of the 30 to 40 billion feet of sawed timber and lumber annually used in this country, of which White Pine furnishes over 30 per cent.

CHARACTER AND PHYSICAL PROPERTIES OF THE WOOD.

The structure of White Pine, like that of other pines, is simple. Ninety per cent and more of the weight of the dry wood is formed by the common wood fibers, or tracheids, 0.12 to 0.20 inches long, well suited for pulp material. The spring wood of each annual ring passes gradually into the summer wood and thus the sharply defined bands of hard, dark and soft, light-colored material so conspicuous in the rings of all hard pine, especially Longleaf and Cuban Pine, are absent in White Pine, making the cutting of the wood by either plane or saw much easier than is the case with hard pines. Sapwood and heartwood are quite distinct—the former white, the latter with a slightly brownish cast. The change from sapwood to heartwood takes place earlier in the young tree and the younger portions of old trees than in older timber. Thus, in a thrifty sapling thirty years old the sapwood shows about eighteen rings on the stump, but only ten rings 35 feet from the ground. In trees over one hundred years old the number of rings in the sapwood is generally over thirty at the stump, decreasing often to fifteen or twenty near the top. The number of rings in the sap, as in other pines, is smaller in thrifty and greater in slow-growing trees, while the width of the sapwood is generally least in slow-growing timber. Compared to other pines, White Pine has a narrow sap at all periods of its growth. While in the hard pines, like the Longleaf Pine, and still more in Loblolly and Shortleaf Pines, the sap forms generally from 50 to 75 per cent of the log, it is generally less than 35 per cent of mill-sized timber in White Pine. This highly valuable property of the White Pine is found in all localities, even in Europe, where the tree has been widely planted.

SPECIFIC WEIGHT.

To determine specific the weight of the wood and other physical properties a collection of seventy-three trees was made, including material from the New England States, Michigan, and Wisconsin, and also from the mountains of North Carolina.

The specific weight of the greenwood varies chiefly with the amount of sapwood and consequent abundance of moisture, since the heartwood contains but little water outside of its cell walls (except in some cases where the heartwood near the stump also contains liquid water). Generally the weight of the greenwood varies from about 40 to 50 pounds per cubic foot, and is greater in young poles than in old timber, which latter on this account floats readily, rarely sinking, even after years of immersion.

The specific weight of the kiln-dry wood varies, generally from 0.33 to 0.40 (20 to 25 pounds per cubic foot), is greater in the old tree than in the young sapling, is greater at the stump than

farther up in the same stem, is independent of orientation (as great on the north side as on the south side), is no greater on clay land than on the sandy soils, and seems in these particulars quite independent of locality. The wood from the swamp trees is no heavier nor lighter than the wood from the upland trees, the trees from New England differing apparently in no way from those of either the Lake region or North Carolina.

Leaving out of consideration the specific weight of the limbs and knots (these being always heavy, as in all pines), the average specific weight of the dry wood of the stem was found to be for—

	Specific gravity.
Five trees 200 to 250 years old	0.386
Five trees 125 to 160 years old	.388
Five trees 100 to 125 years old	.383
Ten trees 75 to 99 years old	.378
Ten trees 50 to 74 years old	.366
Nineteen trees 10 to 49 years old	.353
Nineteen trees 30 to 39 years old	.351

From the above, and still more from the table following, in which the trees are grouped according to age, it will be seen that White Pine displays a uniformity of specific weight, and other properties dependent on weight, such as is entirely unknown in any other pine of the Eastern United States.

Average weight (kiln dry and green), moisture content, and shrinkage per cent of White Pine.

I.—TREES 200 TO 250 YEARS OLD.

Locality.	Original number of trees.	Approximate age of trees.	Diameter breast high without bark.	Width of rings.	Specific gravity × 100.		Moisture as per cent of the weight of dry wood.	Shrinkage in volume.
					Kiln dry.	Green.		
		Years.	*Inches.*	*mm.*			*Per cent.*	*Per cent.*
Lincoln County, Wis.	5	225	23.0	1.1	38.1	69	93	7.6
Marathon County, Wis.	16	250	22.0	.8	38.5	62	73	8.6
Grayling, Mich.	3	205	19.0	1.3	36.0	64	95	8.5
Chippewa County, Wis.	1	209	27.0	1.6	39.0	66	85	8.1
Do.	2	202	19.4	1.0	38.5	66	100	8.0
Do.	3	202	20.5	1.2	39.2	67	81	7.9
Average.					38.6	65	88	8.1
II.—TREES 125 TO 160 YEARS OLD.								
Lincoln County, Wis.	1	146	19.0	1.5	42.0	74	92	9.0
Do.	2	140	22.0	1.9	36.4	72	113	8.7
Do.	3	141	12.0	1.0	38.4	65	92	9.1
Do.	4	140	15.0	1.2	40.5	72	87	9.8
Linville, N. C.	458	158	33.0	2.1	37.1	72	110	7.7
Average.					38.8	71	95	8.9
III.—TREES 100 TO 122 YEARS OLD.								
Grayling, Mich.	1	110	17.5	2.2	36.0	64	96	9.2
Do.	2	122	17.7	1.8	35.0	64	99	9.0
Do.	4	114	9.5	1.1	39.8	79	120	9.8
Do.	5	105	7.5	.9	38.3	76	121	8.5
Do.	7	115	7.8	1.1	46.8	100	138	10.5
Do.	8	108	7.8	1.2	38.9	78	122	8.8
Do.	9	112	7.8	1.3	38.0	85	147	8.8
Do.	10	111	5.0	.8	36.7	71	109	8.5
Average.					38.3	74	119	8.9
IV.—TREES 75 TO 100 YEARS OLD.								
Lincoln County, Wis.	6	75	4.0	0.8	36.3	68	111	8.4
Marathon County, Wis.	12	84	14.0	2.0	39.4	76	110	9.0
Do.	13	90	12.0	2.1	37.0	85	148	9.8
Do.	14	81	15.0	2.7	36.0	73	121	9.0
Do.	15	95	10.0	1.4	40.4	72	88	9.4
Grayling, Mich.	6	93	7.0	1.6	40.1	90	119	8.7
Chippewa County, Wis.	5	83	7.0	1.5	36.3	76	132	9.8
Do.	6	94	6.3	1.0	37.0	71	115	8.0
Do.	7	84	10.4	2.4	37.1	76	128	9.8
Do.	9	78	10.2	1.8	38.5	76	119	8.7
Average.					37.8	76	112	9.0

Average weight (kiln dry and green), moisture content, and shrinkage per cent of White Pine—Continued.

V.—TREES 50 TO 71 YEARS OLD.

Locality.	Original number of trees.	Approximate age of trees.	Diameter breast high without bark.	Width of rings.	Specific gravity × 100.		Moisture as per cent of the weight of dry wood.	Shrinkage in volume.
					Kiln dry.	Green.		
		Years.	*Inches.*	*mm.*			*Per cent.*	*Per cent.*
Lincoln County, Wis	7	60	4.5	1.3	34.3	80	148	8.5
Do	8	50	2.0	.7	39.3	70	.....	8.5
Do	11	52	5.5	1.7	33.8	86	.....	8.6
Chippewa County, Wis	8	65	8.0	2.9	38.7	78	122	9.0
Do	4	73	7.0	1.5	39.0	64	84	10.1
Do	10	67	4.2	1.2	35.7	72	121	8.0
Plymouth County, Mass	1	50	13.0	4.0	35.3	68	112	8.6
Do	4	52	11.0	2.8	38.5	73	106	8.6
Worcester County, Mass	16	54	14.0	3.6	39.0	69	93	8.4
Do	17	65	10.0	2.4	36.5	67	105	7.3
Do	18	60	10.0	2.3	35.5	.....	.....	7.5
Average	.....	.....	.....	.....	36.8	74	115	8.0
VI.—TREES 40 TO 49 YEARS OLD.								
Lincoln County, Wis	9	48	2.3	0.6	43.3	81	102	8.5
Do	10	47	6.0	2.0	31.3	86	162	8.9
Marathon County, Wis	17	40	6.0	2.2	33.5	85	173	9.0
Do	18	40	6.0	2.3	34.5	81	149	8.6
Do	19	40	2.0	1.1	33.7	71	124	8.3
Do	20	42	2.8	1.0	35.0	67	105	8.4
Do	21	44	4.0	1.4	33.8	82	158	7.9
Plymouth County, Mass	2	46	8.5	2.6	36.2	58	76	8.4
Do	3	45	9.2	3.0	36.2	65	95	8.5
Do	5	49	13.7	3.9	35.0	61	93	8.4
Do	6	47	9.5	2.8	38.0	64	81	8.1
Do	10	48	12.5	3.6	34.5	65	108	9.3
Do	11	49	10.3	3.1	39.0	67	89	9.3
Do	12	46	10.2	2.9	37.2	70	104	7.0
Worcester County, Mass	25	46	10.0	2.7	35.0	66	103	8.1
Do	26	45	12.8	3.8	35.5	67	106	8.6
Do	27	45	9.1	2.6	37.7	75	118	9.4
Merrimack County, N. H	32	41	10.3	3.4	33.0	61	98	7.9
Do	33	40	8.6	3.1	31.7	64	122	8.4
Average	.....	.....	.....	.....	35.3	70	113	8.4
VII.—TREES 30 TO 39 YEARS OLD.								
Marathon County, Wis	22	38	4.0	1.5	31.3	77	162	8.2
Plymouth County, Mass	7	36	8.3	3.5	36.5	64	93	8.3
Do	8	34	9.1	3.4	35.2	66	105	9.2
Do	9	35	12.0	4.7	35.7	66	100	7.7
Middlesex County, Mass	13	38	11.0	3.4	35.2	74	131	9.1
Do	14	38	10.8	3.6	33.7	74	147	8.2
Do	15	37	10.8	3.7	36.0	83	146	7.5
Worcester County, Mass	19	35	9.2	3.6	36.1	61	85	8.1
Do	20	33	11.2	4.8	33.6	65	108	7.0
Do	21	31	6.5	2.9	35.2	63	99	9.5
Do	22	33	10.5	4.4	33.0	72	143	9.3
Do	23	36	9.2	3.6	35.2	68	111	8.7
Do	24	35	7.9	2.9	34.5	66	109	8.2
Merrimack County, N. H	28	38	6.8	2.4	38.5	66	89	9.8
Do	29	37	7.1	2.8	36.7	67	108	10.2
Do	30	37	8.2	3.0	36.7	71	111	8.5
Do	31	39	9.5	3.2	37.7	65	99	9.0
Do	34	34	7.5	3.3	32.7	71	129	7.5
Do	35	35	9.3	3.7	34.5	74	123	9.2
Do	36	35	10.3	3.9	30.0	64	147	8.0
Average	.....	.....	.....	.....	35.1	68	104	8.5
VIII.—TREES 20 TO 30 YEARS OLD.								
Linville, N. C	459	22	4.0	2.7	34.7	83	164	9.4
Do	460	26	7.0	2.8	36.9	85	156	10.2
Average	.....	.....	.....	.....	35.5	84	165	9.8

From the table it appears that the specific weight of the timber is quite independent of the rate of growth, and that the individual variation generally moves within very narrow limits. The diagrams (figs. 16 and 17) show the relation of weight for the different sections from the stump

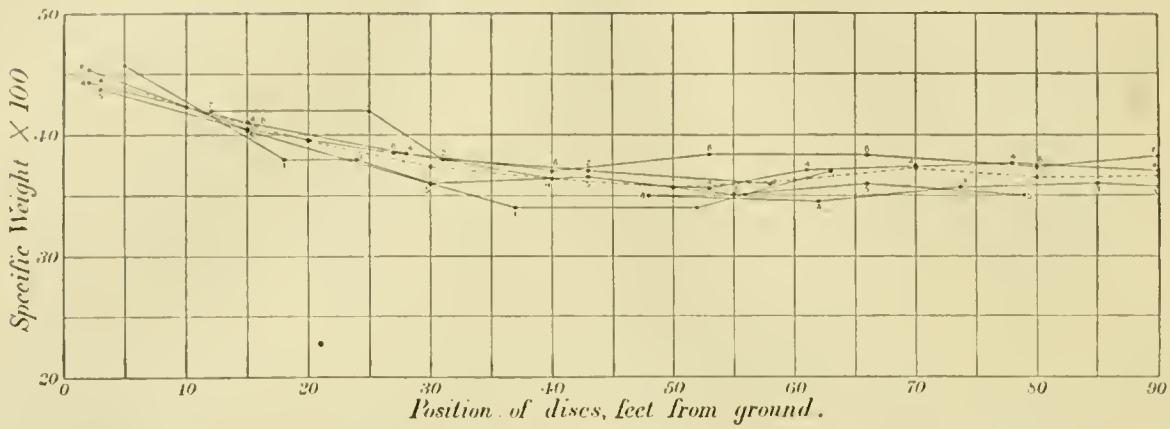


FIG. 16.—Diagram showing specific weight of wood at different cross sections of the stem; also a decrease of weight from the stump upward, and the similarity of the wood of different trees. (Five trees, over 200 years old. Dotted line indicates the average.)

upward; the slightly greater weight of the older timber, as compared to sapling material, the uniform decrease in weight from stump upward, and also the uniformity of the several individuals of any group of trees is clearly apparent from the lines. The same decrease in weight from below

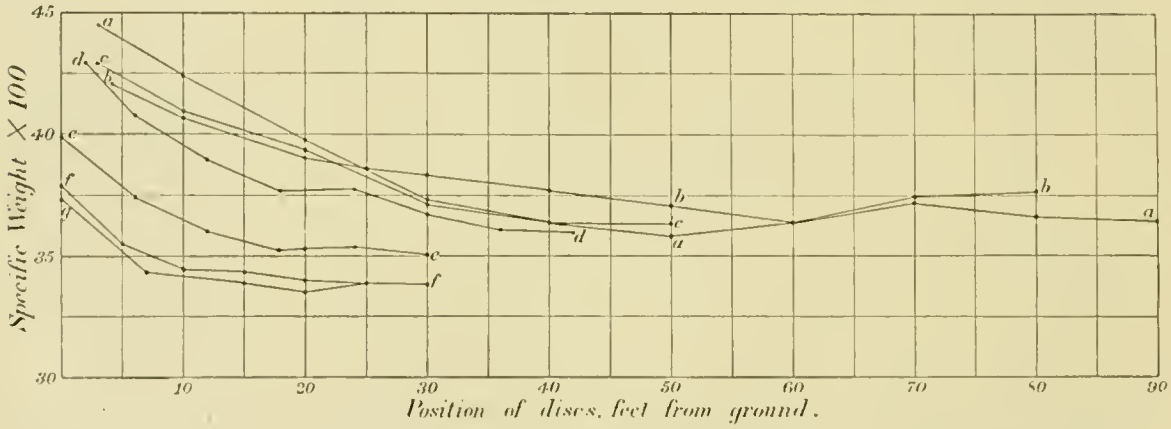


FIG. 17.—Diagram showing specific weight of kiln-dry wood at different points in the stem from ground upward: *a*, six trees, 200 to 250 years old; *b*, five trees, 125 to 160 years old; *c*, seven trees, 100 to 125 years old; *d*, ten trees, 75 to 100 years old; *e*, ten trees, 50 to 74 years old; *f*, eighteen trees, 40 to 49 years old; *g*, nineteen trees, 30 to 39 years old.

upward is observed in the wood of any given period of growth; thus, the wood of the last forty rings (next to the bark) was found to be as follows:

Decrease in weight of the wood of the last (outer) forty rings in the several disks from stump upward.

Disk number.	Specific gravity.			
	Tree No. 458.	Tree No. 1.	Tree No. 2.	Tree No. 3.
I	0.37	0.42	0.44	0.45
II	.31	.39	.40	.405
III	.30	.36	.36	.39
IV	.295	.35	.36	.36
V	.31	.33	.....	.37

As in other pines, there is usually an increase of weight in the crown, apparently due to an influence of the limbs, but as this influence is local, so the apparent result is local, and the weight is very irregular for the crown part of the stem; the pronounced increase is apparent only in the immediate vicinity of the limbs. The absence of a pronounced or sharply defined summer wood makes it difficult and impracticable to apply the microscopic methods to determine the variation of weight from pith to bark on any cross section. From the actual determinations of weight, it appears that for the lower portions of any normally grown tree there is usually at first an increase of weight from the pith outward, reaching a maximum somewhere between the fiftieth and eightieth ring, maintained for a long period and usually followed by a very slow decrease in weight from there on outward. This variation is generally small, and never reaches the proportions met in sections of hard pine, such as Longleaf Pine, where it commonly amounts to 75 to 100 per cent of the weight of the lightest portion.

Usually about half the weight of a green log is water. The amount of moisture generally varies in the sapwood from about 120 to 160 per cent and from 40 to 60 per cent in the heartwood, the amount for the entire log, therefore, varying with the proportion of sap and heart is greatest in saplings and least in large mature trees, in the latter from about 90 to 120 per cent of the weight of the timber after it is kiln-dried. The wood parts with its moisture as easily as any wood in the market, dries rapidly, with little injury, and may safely be kiln-dried fresh from the saw, though in actual practice this method is almost unknown in the White Pine regions, the usual way of drying by carefully piling in immense piles, being the universal way of seasoning. Well air-dried White Pine, as in an ordinary room, still retains 8 to 9 per cent moisture, and if unprotected by oil, paint, etc., is quite susceptible to changes of humidity, absorbing and giving off moisture at every change of temperature and humidity of the air.

SHRINKAGE.

In keeping with its smaller specific weight, the shrinkage of White Pine is less than that of other pines. It is greater for sap than heart, and therefore greater for sapling timber than for older trees. From the table on page 71 it appears that the shrinkage in volume varies for the several groups of trees from 8 to 9 per cent, and, like the weight, is quite uniform for the different individuals of each group.

The ease and rapidity with which White Pine seasons, and the manner of distribution of White Pine lumber, encouraging proper seasoning before use, have done much to earn for White Pine the fame of being one of the woods which do "not shrink" nor "work," a virtue which is not only in part due to the small weight and consequent small shrinkage, but is largely the result of proper handling.

STRENGTH.

Being the lightest, White Pine is also the weakest among the pines of the Eastern United States, as appears from the following general average:

Strength of White Pine at 12 per cent moisture.

	Pounds per square inch.
Compression endwise and in bending to true elastic limit	5,200
Bending to rupture	7,900
Modulus of elasticity	1,410,000
Compression across the grain (3 per cent deformation)	720
Shearing parallel to fiber	380

Out of about seven hundred tests made by the Division of Forestry, about 55 per cent fall within 10 per cent of this general average, and 90 per cent within 25 per cent of the same. Though the test series for White Pine was by no means as full as is desirable, the above average results will probably be found fairly accurate and sufficient for general purposes. The table on the next page presents the average results for the several trees.

Average strength of the wood of White Pine of different trees at 12 per cent moisture.

Locality.	Original number of trees.	Modulus of elasticity (1,000 pounds).	Bending to— Rupture.	Bending to— Relative elastic limit.	Compression endwise.	Compression across grain, to 5 per cent deformation.	Shearing parallel to fiber.	Average specific weight.
			Pounds per sq. in.	*Pounds per sq. in.*	*Pounds per sq. in.*	*Pounds per sq. in.*	*Pounds per sq. in.*	
Wisconsin	101	1,360	8,100	6,200	4,600	690	460	0.42
Do	102	1,520	7,400	5,300	4,200	560	320	.36
Do	104	1,350	7,800	6,000	4,800	620	430	.40
Do	112	1,330	8,300	6,300	5,000	650	440	.39
Do	114	1,190	*a* 6,800	5,600	4,250	630	400	.36
Do	116	1,350	8,300	5,900	5,000	560	470	.385
Michigan	601	1,370	7,400	6,300	5,500	810	350	.38
Do	602	1,470	7,800	6,700	5,700	860	420	.37
Do	603	1,470	7,850	6,650	5,400	790	320	.38
Wisconsin	607	1,380	8,000	6,800	5,700	910	340	.39
Do	608	1,560	8,900	7,450	5,700	670	330	.385
Do	609	1,510	8,200	6,700	6,200	880	340	.392
Average		1,410	7,900	6,300	5,200	720	380	.384
Average for trees 601 to 609		1,460	8,000	6,760	5,700	8,200	350	38.3

a Insufficient data for a fair average.

In the above table the data for trees 101 to 116 are insufficient. Both material and tests for trees 601 to 609 were satisfactory in every respect, and the results, therefore, of far greater value than those for trees 101 to 116.

In keeping with its greater weight, the wood of the butt logs is slightly stronger than that of the top logs, and there is generally a regular difference between different parts of the same cross section, the center, as appears usual in pine, being the weakest, the heavier intermediate portion the strongest, and the peripheral part lying between the two.

For a more careful study of this relation, tests were made of a set of 2 by 2 inch sticks cut out of one log from each of three trees, in such a manner that the centers of the logs formed one set, the part midway from center to bark another set, and the outer portion of the logs a third or outer set, the latter two being all quarter-sawed pieces. The tests furnished the following average results:

Strength of 2 by 2 pieces at 12 per cent moisture.

Kind of test.	Tree No. 601.	Tree No. 602.	Tree No. 603.
	Pounds per sq. in.	*Pounds per sq. in.*	*Pounds per sq. in.*
Compression endwise	6,710	6,890	6,310
Bending to relative elastic limit	7,960	7,970	7,890
Bending to rupture	9,360	9,630	9,340
Modulus of elasticity (1,000 pounds)	1,306	1,291	1,285

It is apparent from the above that the perfect quarter-sawed material confirmed the other test results in showing the great similarity of the wood of these three trees. It also shows, however, that the effect of defects in an unselected lot reduces the strength values markedly in this species.

Arranging the results according to the position of the test pieces in the log, it is found that in compression endwise the strength was: Center pieces, 5,520 pounds, or 78 per cent; intermediate, 7,000 pounds, or 100 per cent; outside pieces, 6,680 pounds, or 95 per cent; showing that the heart pieces, as has been found in other conifers, are always the weakest, thus verifying the results of the general series. The slight decrease from the intermediate to the outside pieces is in keeping with the smaller weight of the latter and need not be ascribed to the fact that these pieces contained small proportions of sapwood. As might be expected, the uniformity of results in this properly selected and prepared material was greater than in the ordinary series. Of 58 tests, all fell within 25 per cent of the average strength and 76 per cent within 10 per cent of the average.

In connection with a general study into the maximum uniformity of wood, three scantlings of White Pine, with an average specific gravity of about 0.34 and an average compressive strength at 8 per cent moisture of 4,900 pounds, were examined, two being tested air-dry (8 per cent) and

the other after being soaked for three months in cold water. The results of these tests on White Pine are embodied in the following table:

Strength of contiguous blocks of the same scantling of White Pine, select material, in compression endwise.

[Dimensions generally, 2.76 by 2.76 by 2.76 inches.]

Number of block.	Dry scantling.		Soaked scantling.	Number of block.	Dry scantling.		Soaked scantling.
	1	2	3		1	2	3
	Pounds per sq. in.	*Pounds per sq. in.*	*Pounds per sq. in.*		*Pounds per sq. in.*	*Pounds per sq. in.*	*Pounds per sq. in.*
1	4,850	5,070	2,270	26	5,070	4,860	
2	4,860	5,150	2,390	27	4,940	4,910	
3	4,690	5,020	2,300	28	5,020	5,010	
4	4,840	4,770	2,260	29	5,110	4,950	
5	4,760	4,770	a 5,700	30	5,020		
6	4,720	4,920	2,390	31	4,950		
7	4,730	4,950	2,300	32	4,820		
8	4,760	4,840	2,310	33	4,950	4,690	
9	4,750	4,860	2,290	34	4,900	4,750	
10	4,770	a 6,460	2,310	35	5,040	4,670	
11	4,730	4,860	2,340	36	5,160	4,630	
12	4,760	5,010	2,210	37	5,120	4,800	
13	4,770		2,370	38	5,100	4,730	
14	4,670		2,340	39	5,230	4,660	
15	4,660	4,960	2,340	40	5,280	a 6,000	
16	4,660		2,340	41	5,260	4,840	
17	4,590		2,330	42	5,280	4,780	
18	4,600		a 5,710	43	5,300	4,840	
19	4,610	4,910	2,310	44	5,310	4,870	
20	4,880	a 6,600	2,260	45	5,300	5,040	
21	4,920	4,600	2,180	46	5,350	5,150	
22	4,870	4,650	2,130	47	5,406	5,340	
23	4,970	4,720		48	5,360	5,300	
24	4,940	4,860		49	5,360	5,200	
25				50	5,510		

a Dried at 180° F. (to about 2 per cent moisture) before testing.

It appears that in the tests on dry material the greatest difference between any two contiguous blocks of select quarter-sawed White Pine was 190 pounds per square inch, or 3.8 per cent of the total strength; that generally it was less than 2 per cent, and several times only about 0.2 per cent, but that in tests of this kind less then 200 pounds in the results can not be regarded as any difference at all, this amount being due to indeterminable differences found even in the best material, and partly due also to imperfections in the means and methods of testing. It is also clear that in the same scantling, though select and of small dimension (only 6 feet long) a difference of nearly 900 pounds per square inch, or 18 per cent of the strength, in compression endwise may be found, so that any inferences from scantling to scantling must be taken with great caution, and any accurate relations, such as the influence of seasoning, etc., can be made only in a manner similar to that employed in these uniformity tests.

From the general series of tests, also from the tests on the select 2 by 2 inch pieces, and in way of indication also from some of the tests in maximum uniformity, it appears that seasoning affects the wood of White Pine to about the same degree as that of other pines. The strength of greenwood, or wood soaked to a point where additional immersion no longer changes the volume, is independent of differences in moisture. This is quite clear from the test in uniformity of the scantling immersed for three months. Though the blocks differed (especially near the ends) within wide limits as to the amount of moisture they contained, yet the strength was found to be as uniform as in evenly dried timber. By drying green or fully saturated wood to about 2 per cent moisture (kiln-drying at 80° C.), the strength is more than doubled; and even if pieces well air-dried are kiln-dried the strength is still increased by over 40 per cent. For timber to be used under cover and kept properly ventilated, it is safe to presume that the strength, once seasoned, will be 50 per cent greater than when green, and if used in heated rooms, an increase of 100 per cent on the strength of the green timber may reasonably be expected. The diagram (fig. 18) well illustrates this feature.

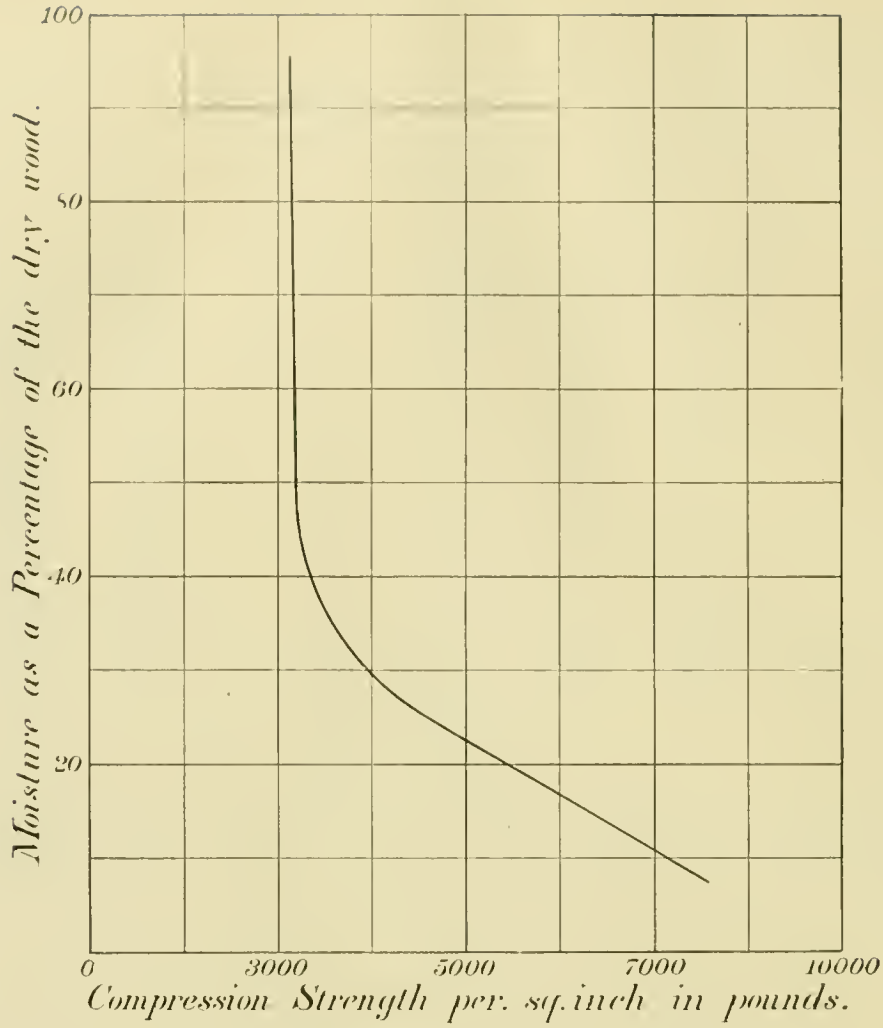


FIG. 18.—Diagram showing effect of moisture on crushing strength.

DURABILITY.

With regard to its durability, White Pine is generally underrated. The soft, light-colored wood suggests general frailty and a lack of resistance, in which resistance to decay is included. In the region where it grows the unusual great durability of the heartwood of White Pine is well known; "the stumps of White Pine last a lifetime;" old logs, covered with moss and often with young Poplars and Birch growing from their surface are uncovered and utilized as shingle bolts. White Pine shingles wear out, but rarely decay, and a good sidewalk of White Pine is considered the best to be had. As in other pines, the sapwood decays readily, but this being narrow in good logs, more than half of all White Pine sawed is good durable heart, a wood which is neither subject to decay nor to the boring insects any more than the heavy resinous heart of the Red Pine or of the Southern pines.

COMPARISON WITH OTHER WOODS.

Generally White Pine is logged and milled on a large scale, cut mostly into boards and plank, and there is to-day no common wood which is more economically handled and more carefully selected.

Compared to other pines, the White Pine is offered more extensively and has a greater influence on lumber markets than any other wood used. It is more uniform, lighter, softer, and

shrinks less than any other pine; it is durable, insect proof, and suited to a much greater number of uses than the wood of other pine..

The following table exhibits the position of White Pine as to weight and strength:

Weight and strength of White Pine compared with other pines.

Name of pines.	Specific gravity.		Bending.				Compression endwise.	
			Rupture.		To relative elastic limit.			
	Actual.	Relative.	Pounds per square inch.	Relative.	Pounds per square inch.	Relative.	Pounds per square inch.	Relative.
Longleaf	61	100	12,800	100	10,300	100	8,300	100
Loblolly	53	87	11,800	92	9,500	92	7,800	94
Shortleaf	51	84	10,400	81	7,800	76	6,500	78
Red or Norway	48	78	9,100	71	7,700	75	6,700	81
White	38	62	7,900	62	6,400	62	5,200	62

Of the several columns, that on specific weight being at once the simplest and most truly representative of the entire stem of mature timber, illustrates probably the relative position of these five pines most perfectly. The Southern pines, if only the saw timber is considered, will prove even heavier and stronger by several per cent than appears from this table.

USES OF WHITE PINE.

There is no wood in the United States, perhaps in the world, of which there is a greater quantity used, nor one which is put to a greater variety of uses than that of the White Pine. At present the great mass of White Pine, probably not less than 95 per cent of the entire output, is cut into even lengths, usually 12 to 18 feet long, preferably 16 feet (full 75 per cent being 16 feet), and is converted principally into boards, plank, and "dimension stuff," 1 to 4 inches thick and 4 inches and upward in width, the widths varying always by an even number of inches.

In all the better mills the slabs are cut into laths, pickets, etc., while the thickest slabs and the sound portions of very defective logs are cut into shingles. These "shingle cants" are of variable sizes, usually containing knots and decayed portions; these defects in the shingle are cut out subsequently by the knot sawyers. Shingles of regular widths are rarely made. In the sawing of the great mass of lumber the main saw merely cuts slices of various thicknesses from the logs, and their conversion into certain widths, as well as the removal of uneven edges, is left to the edger, on whose knowledge and skill much of the success of the mill depends. Usually the clear stuff, whenever possible, is left in broad and thick planks; the rest is cut into different widths so as to insure the greatest value, in most cases boards of extra width and select boards, for siding, etc., receiving preference and determining the conversion. The clear stuff, or "uppers," rarely forming over 15 per cent of the cut in our times, are used by manufacturers of sash, doors, and blinds, and by furniture men, and the most select portions by model makers and other special manufacturers where the price of the material is of secondary consideration. For material of this kind the consumer generally pays over $50 per 1,000 feet B. M., and in some cases it is retailed at over $100. Of the remainder, the great mass is used in the construction of frame houses, where commonly everything of wood, from cellar to roof, is made of this material. Of the inferior grades, enormous quantities are used for boxes, and much also is used as fencing and barn lumber.

For box shooks, straight-stave cooperage, pails, tubs, etc., a great deal of small sapling pine is employed. Smaller quantities of better-grade White Pine are used in mill constructions (for chutes, elevators, etc.); also in the manufacture of farm implements, for large surfaces, panelwork, etc., and in boat and ship building for decking, in fitting up cabins, for all kinds of spars, where its lightness, stiffness, and durability, together with its fine form and dimensions, render it a special favorite.

Considerable quantities of hewn and round timbers are still brought to market for export, but on the whole this trade is insignificant when compared to the entire output.

White Pine is universally seasoned in the yard; most of the lumber does not reach the consumer until a year after manufacture. The ease of working induces the consumers to do a great deal of

resawing. The flooring, and even siding for the smaller markets, and for cheap construction are commonly the selected parts of sheathing and other inferior grades, as classed at the mill, and it is rare to find, in recent years, the best grades of White Pine in the smaller retailers' yards.

In the classification of White Pine a great degree of finesse has been introduced, and the closest attention is paid here, as well as in edging and trimming, to the probable future use of a given piece of material.

From the enormous consumption of White Pine alone, and also from the great variety of uses to which it is put, it is clear that any material diminution of supplies must affect extensively and intimately the wood market and wood industries of this country. The common claim of substitution of some other pine or conifer, and still more the belief in the use of hardwoods in the place of White Pine, have but little in their favor. A shipping case of White Pine requires about half the effort to make and only 50 to 65 per cent of the effort to haul or handle as one made of Southern Pine, its most natural substitute. Similarly, a White Pine lath nails with half the effort, shrinks less, and thus is far more satisfactory than one made of hard pine. For a good door or for satisfactory sash and blinds only the Cypress and White Cedar can enter as a substitute, and both are too restricted in their occurrence, and the Cypress has too little chance of future regeneration to deserve consideration as a general substitute. The transportation of Pacific coast timbers, a small portion of which have the properties of White Pine, to the densely populated Eastern United States is not likely to occur on a large scale, for the cost of hauling alone equals the value of good grades of Eastern lumber.

APPENDIX.

TABLES OF MEASUREMENTS.

APPENDIX.

TABLES OF MEASUREMENTS.

The following tables record the detail investigations, measurements, and tabulations which have served as a basis for the discussion of the growth of the White Pine. The measurements in the field were made by Mr. Austin Cary, of Bangor, Me., and by Mr. A. K. Mlodziansky, of the Division of Forestry. Mr. Mlodziansky has also executed the laborious calculations, and is responsible for their accuracy.

The methods employed in this investigation have been described in general in Bulletin No. 20, "Measuring the forest crop," of the Division of Forestry. They are in the main similar to those practiced by European foresters, with some minor and one important modification, which latter Mr. Mlodziansky has developed during the course of his work in collating the data. This modification, which refers to the analyzing of trees for ascertaining the rate of growth, consists in grouping by age classes, and instead of analyzing each single-measured tree, as is usually done in European practice, averages the data of measurement from a number of trees grouped and then analyzes the growth of the average tree thus constructed of each age class or group. In this way the work of collating is very considerably reduced and the measurements of a very much larger number of trees can be expeditiously utilized for average statement. It is needful, however, in order to be quite satisfactory, that the classification or grouping of trees be made in the woods while measuring, a task which requires considerable judgment. When the classification is so done in the woods, the mechanical work is further simplified by entering the measurements for each group in sets, the measurements of cross sections taken at the same height being entered on the same sheet for all trees of the group, when the averaging of the measurements can at once be performed on the same sheets.

The forms used in the investigation are also appended, and will serve to further elucidate the methods pursued.

Since it was not expedient to fell trees specially for these measurements, it was not always possible to secure all measurements in the most desirable form; for instance, the desirable measurement and correlation to age of diameters at breast height, and at short intervals of the height, could not be obtained, because the work was performed on trees cut in regular lumbering operations; hence, the data had to be manipulated and interpolations used so as to secure satisfactory approximations for the periodic growth. The number of trees analyzed (some 700) is so large that any deficiency of method may be considered as neutralized.

TABLES OF CUBIC AND BOARD CONTENTS OF WHITE PINE.

The tables of cubic and board contents of White Pine are based upon the measurements of pine taken for analysis from the various sites described in the tabulations of acre yields.

The stem of each individual tree was calipered at intervals of 4 or 8 feet, and the volumes of the portions between two successive diameter measurements were calculated separately, considering them as frustrums of cones. From the volumes of stems of similar height and diameter, breast high, the average volume was noted. The volumes of stems of missing dimensions was calculated by employing the corresponding factors of shape. The factor of shape is determined by dividing the volume of a tree by that of a cylinder of the same height and diameter, breast high; it shows the taper of the stem and is usually expressed in decimals, thus representing arithmetically the form of the stem. For determining the volume of a tree by means of the factor of shape, it is necessary only to measure the diameter and height of the tree, find the volume of a cylinder of the corresponding height and diameter, and multiply that volume by the factor of shape.

The lumber of stems in board feet was determined by employing Scribner's rule.

TABLE I.—*Volumes of boles of White Pine.*

[Age of trees, 30 to 250 years.]

Diameter (breast high).	Height of trees, in feet.																											Diameter (breast high).	Factor of shape of the boles.
	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175		
	Contents of the boles with bark, in cubic feet.																														
Ins.																														*Ins.*	
5	2.4	2.8	3.1																											5	0.51
6		3.9	4.5	5.0	5.5																									6	.507
7		5.4	6.0	6.7	7.4	8.0																								7	.502
8		6.9	7.8	8.7	9.5	10.4																								8	.497
9		8.7	9.8	10.9	12.0	13.0	14.1																							9	.492
10		10.7	12.0	13.3	14.6	15.9	17.3	18.6																						10	.488
11		12.8	14.4	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0																11	.484
12			17.0	18.9	20.8	22.7	24.6	26.5	28.4	30.3	32.2	34.1	36.0	37.9																12	.480
13			19.8	22.0	24.2	26.4	28.6	30.8	33.0	35.2	37.4	39.6	41.8	44.0	46.2	48.4	50.6	52.8												13	.477
14			22.8	25.3	27.8	30.3	32.8	35.3	37.8	40.3	42.8	45.3	47.8	50.3	52.8	55.3	57.8	60.3												14	.474
15					31.7	34.6	37.5	40.4	43.3	46.2	49.1	52.0	54.9	57.8	60.7	63.6	66.5	69.4	72.3											15	.470
16						38.9	42.1	45.3	48.5	51.7	54.9	58.1	61.3	64.5	67.7	70.9	74.1	77.3	80.5											16	.465
17						43.4	47.0	50.6	54.2	57.8	61.4	65.0	68.6	72.2	75.8	79.4	83.0	86.6	90.2											17	.460
18							51.9	55.9	59.9	63.9	67.9	71.9	75.9	79.9	83.9	87.9	91.9	95.9	99.9											18	.452
19							56.9	61.3	65.7	70.1	74.5	78.9	83.3	87.7	92.1	96.5	100.9	105.3	109.7	114.1										19	.445
20									72.0	76.8	81.6	86.4	91.2	96.0	100.8	105.6	110.4	115.2	120.0	124.8										20	.440
21									77.6	82.8	88.0	93.2	98.4	103.6	108.8	114.0	119.2	124.4	129.6	134.8	140.0									21	.430
22											95.6	101.2	106.8	112.4	118.0	123.6	129.2	134.8	140.4	146.0	151.6									22	.426
23											104.0	110.1	116.2	122.3	128.4	134.5	140.6	146.7	152.8	158.9	165.0	171.1	177.2							23	.424
24											113.0	119.6	126.2	132.8	139.4	146.0	146.6	153.2	159.8	166.4	173.0	179.6	186.2							24	.423
25											121.7	128.8	135.9	143.0	150.1	157.2	164.3	171.4	178.5	185.6	192.7	199.8	206.9							25	.420
26												138.8	146.5	154.2	161.9	169.6	177.3	185.0	192.7	200.4	208.1	215.8	223.5							26	.419
27												149.6	157.9	166.2	174.5	182.8	191.1	199.4	207.7	216.0	224.3	232.6	240.9	249.2						27	.418
28													169.4	178.3	187.2	196.1	205.0	213.9	222.8	231.7	240.6	249.5	258.4	267.3	276.2					28	.417
29													180.8	190.3	199.8	209.3	218.8	228.3	237.8	247.3	256.8	266.3	275.8	285.3	294.8					29	.415
30													192.6	202.7	212.8	222.9	233.0	240.1	250.2	260.3	270.4	280.5	290.6	300.7	310.8					30	.413
31													205.1	215.9	226.7	237.5	248.3	259.1	269.9	280.7	291.5	302.3	313.1	323.9	334.7					31	.412
32														229.0	240.4	251.8	263.2	274.6	286.0	297.4	308.8	320.2	331.6	343.0	354.4					32	.410
33														242.9	255.0	267.1	279.2	291.3	303.4	315.5	327.6	339.7	351.8	363.9	376.0	388.1				33	.409
34														257.2	270.1	283.0	295.9	308.8	321.7	334.6	347.5	360.4	373.3	386.2	399.1	412.0				34	.408
35															285.5	299.1	312.7	326.3	339.9	353.5	367.1	380.7	394.3	407.9	421.5	435.1	448.7	462.3	475.9	35	.407
36															301.3	315.6	329.9	344.2	358.5	372.8	387.1	401.4	415.7	430.0	444.3	458.6	472.9	487.2	501.5	36	.406
37																332.6	347.7	362.8	377.9	393.0	408.1	423.2	438.3	453.4	468.5	483.6	498.7	513.8	528.9	37	.405
38																	365.9	381.8	397.7	413.6	429.5	445.4	461.3	477.2	493.1	509.0	524.9	540.8	556.7	38	.404
39																			418.1	434.8	451.5	468.2	484.9	501.6	518.3	535.0	551.7	568.4	585.1	39	.403
40																			437.4	454.9	472.4	489.9	507.4	524.9	542.4	559.9	577.4	594.9	612.4	40	.401
41																						513.4	531.7	550.0	568.3	586.6	604.9	623.2	641.5	41	.400
42																						537.4	556.6	575.8	595.0	614.2	633.4	652.6	671.8	42	.399
43																						561.9	582.0	602.1	622.2	642.3	662.4	682.5	702.6	43	.398
44																						586.9	607.8	628.7	649.6	670.5	691.4	712.3	733.2	44	.397
45																						612.3	634.2	656.1	678.0	699.9	721.8	743.7	765.6	45	.396
46																						638.2	661.0	683.8	706.6	729.4	752.2	775.0	797.8	46	.395
H't.	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	Height.	

TABLE II.—*Actual tapering and board contents of stems of White Pine from 5 to 51½ inches in diameter, breast high.*

Height of tree in feet.	Diameter (in inches) with bark at a height from ground of—								Number of 16-foot logs of 5 inches and more at small end.	Lumber.
	Breast high.	16 feet.	32 feet.	48 feet.	64 feet.	80 feet.	96 feet.	112 feet.		
35	5.2	4.0	1.2	.....	.....	.....	.....	.....	.....	.....
45	5.1	4.3	2.6	.....	.....	.....	.....	.....	.....	.....
40	6.0	5.0	2.3	.....	.....	.....	.....	.....	1	.....
55	6.2	5.4	3.9	1.7	.....	.....	.....	.....	1	.....
45	7.1	5.7	3.2	.....	.....	.....	.....	.....	1	8
60	7.2	6.2	5.0	2.4	.....	.....	.....	.....	2	12
50	8.1	6.7	4.2	.....	.....	.....	.....	.....	1	8
55	8.0	6.8	5.3	2.3	.....	.....	.....	.....	2	12
55	9.1	7.7	5.6	2.8	.....	.....	.....	.....	2	19
45	9.5	8.0	4.2	.....	.....	.....	.....	.....	1	15
70	9.2	7.7	6.5	.....	.....	.....	.....	.....	2	23
55	10.1	8.7	6.3	3.6	.....	.....	.....	.....	2	30
70	10.2	9.1	8.1	5.5	.....	.....	.....	.....	3	48
45	11.3	8.8	4.1	.....	.....	.....	.....	.....	1	22
55	11.2	9.2	6.8	3.4	.....	.....	.....	.....	2	37
65	11.1	9.6	8.2	5.5	2.7	.....	.....	.....	3	55
55	12.3	10.0	7.0	3.0	.....	.....	.....	.....	2	44
80	12.1	10.6	9.3	7.5	4.2	.....	.....	.....	3	80
60	12.0	10.0	7.5	3.8	.....	.....	.....	.....	2	44
45	13.5	10.9	4.2	.....	.....	.....	.....	.....	1	36
60	13.2	10.9	8.1	3.4	.....	.....	.....	.....	2	58
75	13.0	11.1	10.0	7.5	5.0	.....	.....	.....	4	87
80	13.1	11.8	10.2	8.5	6.0	4.7	.....	.....	5	115
95	13.2	12.0	10.6	8.2	5.7	.....	.....	.....	4	122
120	13.0	12.2	11.5	10.3	9.5	8.0	6.5	.....	6	193
55	14.2	11.9	8.2	3.7	.....	.....	.....	.....	2	71
65	14.2	12.0	9.7	4.5	.....	.....	.....	.....	2	93
75	14.2	12.1	10.8	8.5	4.9	.....	.....	.....	4	126
85	14.2	12.9	11.3	8.7	5.5	4.0	.....	.....	4	139
95	14.0	12.3	11.4	9.5	7.0	3.3	.....	.....	4	157
70	14.7	13.0	10.7	7.2	.....	.....	.....	.....	3	115
85	15.0	13.3	11.8	9.7	6.2	.....	.....	.....	4	167
95	15.0	13.4	12.0	10.2	7.8	5.1	.....	.....	5	200
115	15.1	13.9	12.9	11.7	10.3	8.5	6.8	.....	6	284
60	16.0	14.0	9.5	6.2	.....	.....	.....	.....	3	118
85	16.1	14.0	12.3	10.0	6.6	.....	.....	.....	4	189
95	16.4	14.1	13.0	11.1	8.3	5.5	.....	.....	5	237
105	16.4	14.3	12.9	11.6	9.6	6.8	.....	.....	5	274
120	16.5	15.5	14.0	13.0	12.0	10.0	7.5	.....	6	317
60	17.0	14.3	8.0	.....	.....	.....	.....	.....	2	96
125	17.0	14.9	13.0	11.6	10.0	6.8	.....	.....	5	257
75	17.0	14.7	12.8	9.4	4.2	.....	.....	.....	3	193
85	17.1	14.6	13.3	11.0	6.7	2.6	.....	.....	4	208
95	17.0	15.2	13.5	11.9	9.1	5.6	2.0	.....	5	263
110	16.9	15.0	13.9	12.2	10.7	8.0	.....	.....	5	303
75	18.5	16.0	13.8	10.2	3.5	.....	.....	.....	3	238
85	18.2	15.4	13.7	11.0	5.2	3.0	.....	.....	4	221
90	18.0	15.2	13.3	11.7	8.6	4.8	.....	.....	5	235
105	18.2	16.0	14.5	13.0	10.2	7.2	.....	.....	5	336
120	17.8	17.0	15.5	14.0	12.0	10.0	7.0	.....	6	397
80	17.8	15.4	12.9	9.8	5.0	.....	.....	.....	3	197
65	19.1	15.9	12.4	8.5	.....	.....	.....	.....	4	192
85	19.0	16.5	14.9	11.9	7.9	.....	.....	.....	4	333
95	19.2	16.3	14.9	12.8	9.4	6.0	.....	.....	5	322
105	19.1	16.6	15.2	13.1	11.0	8.2	7.1	.....	6	394
125	19.1	17.1	16.0	14.8	13.8	12.0	9.5	9.0	7	568
80	20.0	17.4	15.0	10.9	6.8	3.0	.....	.....	4	288
95	20.2	17.5	16.2	13.5	10.5	5.8	.....	.....	5	411
105	20.2	17.4	15.9	14.1	11.1	7.3	3.0	.....	5	410
120	20.3	18.0	16.9	15.1	13.6	11.9	9.2	5.0	7	576
85	21.1	18.5	16.7	13.7	9.4	.....	.....	.....	4	423
95	20.9	18.6	16.9	14.5	11.4	5.7	.....	.....	5	466
105	21.0	18.5	16.9	14.5	11.9	7.8	3.5	.....	5	477
115	21.3	18.4	17.4	15.5	13.6	10.9	7.0	.....	6	566
135	21.0	17.3	15.8	15.0	14.3	11.3	9.5	.....	6	443
85	22.0	18.2	16.0	12.8	7.6	3.2	.....	.....	4	369
95	22.3	19.7	18.1	15.2	11.6	6.2	3.5	.....	5	522
105	22.1	19.5	17.9	16.0	13.3	9.8	6.7	.....	6	587
115	22.1	19.1	17.4	15.8	13.5	10.1	6.5	.....	6	586
95	22.9	19.4	17.5	14.8	11.0	5.3	.....	.....	5	480
105	23.2	19.6	17.8	15.8	12.9	8.7	.....	.....	5	572
115	23.1	20.1	18.8	17.1	14.9	11.7	7.7	.....	6	729
140	23.2	20.1	19.2	17.7	16.4	14.7	11.9	9.0	7	912
85	24.3	20.6	18.6	15.0	9.1	4.4	.....	.....	4	516
100	24.1	21.0	19.0	16.6	12.4	9.0	7.5	.....	6	697
115	24.0	20.4	18.9	17.3	14.6	10.9	6.8	.....	6	709
120	24.2	21.3	19.3	18.2	16.3	12.6	9.9	5.7	7	839
140	24.2	21.0	19.3	18.2	16.4	14.5	9.8	8.0	7	916
85	25.0	21.3	19.0	16.5	9.7	3.5	.....	.....	4	625
95	25.2	21.4	19.7	16.8	10.7	4.4	.....	.....	4	661
105	25.1	21.2	19.5	17.5	13.9	10.1	.....	.....	5	738
115	25.0	21.0	19.2	17.3	14.7	11.7	7.6	.....	6	760
125	25.0	22.0	20.3	19.3	17.3	14.5	11.0	8.5	7	1,012

Height of tree in feet.	Diameter (in inches) with bark at a height from ground of—								Number of 16-foot logs of 5 inches and more at small end.	Lumber.
	Breast high.	16 feet.	32 feet.	48 feet.	64 feet.	80 feet.	96 feet.	112 feet.		
135	25.2	22.2	20.6	19.2	16.8	14.3	11.5	7.3	7	1,018
145	25.1	22.2	20.6	18.8	17.1	15.2	12.6	9.9	7	1,093
90	26.5	21.3	19.3	16.1	12.3	6.8	.....	.....	5	630
105	26.0	21.9	20.2	18.5	14.8	9.1	.....	.....	5	832
115	25.9	22.7	21.3	19.0	16.7	12.9	8.9	.....	6	971
125	26.1	22.5	20.5	19.0	16.6	13.5	10.1	.....	6	971
135	26.2	22.7	21.0	19.7	18.7	16.3	13.8	10.2	7	1,227
145	26.0	22.2	21.0	19.5	17.9	16.1	13.6	10.6	7	1,177
105	27.1	22.9	21.2	18.8	15.0	11.7	.....	.....	5	925
115	27.0	22.6	20.4	18.7	16.5	9.3	5.6	.....	6	887
125	27.0	22.7	21.1	19.4	16.4	14.1	10.4	5.3	7	983
140	26.8	23.6	22.2	20.8	19.0	15.1	12.6	.....	6	1,229
150	27.0	23.1	21.0	19.0	17.5	15.2	12.0	.....	6	1,109
70	28.0	24.2	21.0	18.0	.....	.....	.....	.....	3	784
90	28.5	23.6	21.9	19.5	15.5	7.3	.....	.....	5	974
105	28.0	22.9	20.6	17.9	14.2	9.3	4.0	.....	5	828
115	28.3	23.0	21.0	19.3	16.5	12.9	7.8	.....	6	999
125	28.4	24.8	22.7	20.9	18.4	15.1	8.4	4.7	7	1,230
140	28.3	24.8	23.1	21.6	20.0	17.4	14.5	11.7	7	1,515
155	28.1	25.3	24.2	22.5	20.7	19.0	16.7	12.0	7	1,743
100	29.0	23.7	21.2	18.8	15.4	10.4	8.6	.....	6	934
85	29.0	23.0	20.0	14.5	8.5	.....	.....	.....	4	671
115	29.1	25.0	22.8	20.6	17.2	12.5	7.9	.....	6	1,203
130	29.0	24.2	22.6	21.1	18.9	15.2	12.0	7.4	7	1,279
145	29.1	24.8	23.1	21.4	19.8	18.2	15.4	12.1	7	1,518
100	30.0	26.5	23.8	22.5	16.5	.....	.....	.....	4	1,268
110	30.1	24.6	22.1	20.4	17.6	12.5	6.5	.....	6	1,114
120	30.1	25.1	23.2	21.0	18.4	14.3	9.3	.....	6	1,278
130	30.1	25.8	23.6	21.6	19.1	15.1	10.7	8.0	7	1,388
145	30.0	26.2	24.8	22.9	21.0	18.9	16.3	12.3	7	1,825
95	31.0	26.7	23.8	19.7	14.2	11.7	10.0	.....	6	1,120
115	31.1	27.1	24.3	21.2	18.1	13.2	9.3	.....	6	1,318
125	31.0	25.1	22.7	20.8	17.9	15.1	10.0	.....	6	1,202
135	31.2	26.7	24.2	22.7	20.7	18.5	14.3	10.2	7	1,650
145	31.1	26.7	24.6	22.7	20.8	18.3	15.9	11.5	7	1,684
105	32.0	28.3	25.5	22.7	17.6	12.3	10.0	.....	6	1,395
115	32.0	27.2	24.9	23.2	19.1	13.9	7.1	.....	6	1,409
125	31.9	27.1	24.9	24.0	20.9	16.2	13.4	5.4	7	1,621
135	32.0	25.9	23.9	21.5	19.1	16.5	12.6	10.0	7	1,390
145	32.2	28.2	26.4	24.2	22.1	19.9	16.3	13.3	7	2,023
155	32.2	27.4	26.1	24.1	22.9	21.3	18.5	15.4	7	2,181
110	33.2	29.4	26.2	22.6	18.2	11.0	.....	.....	5	1,511
125	33.1	28.7	26.0	23.8	21.3	16.7	11.6	.....	6	1,779
135	33.1	28.0	25.8	24.0	21.7	18.0	12.6	9.0	7	1,787
145	33.2	27.9	25.8	24.5	22.6	20.0	16.8	12.7	7	1,965
105	34.0	30.0	24.5	21.5	16.5	10.0	.....	.....	5	1,341
115	34.0	27.9	25.7	22.7	18.5	13.9	9.0	.....	6	1,445
125	34.2	28.7	26.1	23.9	21.0	14.9	8.0	5.1	7	1,705
135	34.0	28.3	25.6	24.3	22.2	19.1	15.1	11.7	7	1,877
145	34.0	29.4	27.1	25.3	23.4	20.4	17.5	13.7	7	2,259
155	34.3	29.2	27.7	25.5	23.7	22.0	19.5	15.3	7	2,408
115	35.0	27.8	25.3	23.7	20.3	14.4	10.9	.....	6	1,550
125	35.1	27.8	25.8	23.6	20.8	17.2	12.6	7.0	7	1,672
135	35.2	30.5	28.1	25.7	23.0	20.8	17.5	12.7	7	2,368
145	35.2	30.5	28.0	26.0	23.7	20.0	14.6	12.2	7	2,309
155	35.2	30.3	28.5	26.3	24.5	22.3	19.3	15.7	7	2,512
175	35.0	31.0	29.0	28.0	27.0	24.0	23.0	18.0	7	3,067
105	36.2	29.5	25.0	22.5	19.5	10.0	.....	.....	5	1,490
115	36.1	28.3	26.1	23.0	18.1	14.3	9.2	.....	6	1,521
125	36.0	28.0	23.9	22.1	19.2	15.0	14.0	.....	6	1,474
135	36.0	29.0	28.0	19.0	14.0	10.0	.....	.....	5	1,285
155	36.0	31.3	30.0	28.0	25.0	22.8	18.9	15.0	7	2,800
105	37.0	30.0	25.0	21.5	19.0	14.0	.....	.....	5	1,509
125	36.9	30.5	27.9	25.1	22.7	18.3	13.1	6.0	7	2,035
145	37.0	31.8	30.5	28.7	26.5	24.2	20.8	14.2	7	2,987
155	37.0	29.8	26.5	25.5	23.7	24.0	18.7	14.5	7	2,396
115	38.0	30.0	25.0	23.6	19.9	13.0	8.0	.....	6	1,604
125	38.0	31.5	28.5	26.3	22.9	18.5	12.5	.....	6	2,204
145	38.0	31.5	23.5	22.2	20.5	17.5	13.2	10.0	7	1,751
130	39.0	28.8	27.7	24.0	20.0	14.8	6.8	.....	6	1,706
155	39.0	33.0	30.0	28.5	26.0	23.0	21.5	18.0	7	3,107
135	40.0	33.0	31.2	29.5	25.3	22.0	17.3	10.2	7	2,850
145	41.0	37.2	33.5	31.2	28.4	25.5	20.7	15.7	7	3,561
140	42.0	34.5	31.8	29.0	26.2	23.0	14.3	9.1	7	2,817
150	43.0	36.8	34.1	32.3	29.7	26.2	21.8	16.3	7	3,810
135	44.0	35.6	33.9	30.7	28.7	24.4	19.5	20.0	7	3,589
145	45.0	37.5	34.4	30.6	28.0	23.8	18.3	13.2	7	3,411
140	46.0	30.0	23.0	22.5	20.0	19.0	18.0	10.0	7	1,665
165	46.0	38.7	35.8	34.4	32.4	29.1	25.1	21.3	7	4,702
160	47.0	40.4	37.4	35.3	32.4	29.6	25.9	20.9	7	4,960
140	50.0	41.0	38.0	35.0	31.0	27.0	21.5	13.0	7	4,483
150	51.5	41.5	38.0	34.0	31.5	23.0	18.5	15.5	7	4,350

TABLE III.—*Measurements of White Pine grown under similar conditions, grouped in age classes for averaging.*

[The groups of trees measured are sample trees recorded in Table VI.]

Group, location, and description of site.	Tree number.	Age.	Diameter with bark (breast high).	Total height.	Factor of shape.	Ratio of the length of crown to the total height of the tree.	Volume of boles.	Accretion.	
								Current annual.	Average annual.
GROUP A.									
Massachusetts and New Hampshire.		*Yrs.*	*Inches.*	*Feet.*			*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
White Pine mixed with hardwoods on a hill. Soil, brown or yellowish sandy loam, medium sized grain, light, loose, fresh, and well drained, with a leafy surface cover. Trees, 400–500 to the acre.	21	33	6.5	51.3	0.57	0.37	6.7	.....	.....
	33	42	8.6	65.3	.51	.34	13.1	.....	.....
	2	48	8.5	60.0	.58	.21	13.8	.....	.....
	19	39	9.2	55.2	.58	.42	14.3	.....	.....
	3	48	9.2	62.5	.57	.35	15.6	.....	.....
	31	41	9.5	63.0	.57	.36	16.0	.....	.....
	27	47	9.1	64.0	.56	.40	15.9	.....	.....
	25	47	10.0	62.7	.50	.35	17.0	.....	.....
	20	36	11.2	53.0	.52	.54	18.4	.....	.....
	32	44	10.3	70.0	.50	.34	21.3	.....	.....
	1	55	13.0	71.5	.50	.48	32.7	.....	.....
	26	47	12.8	69.5	.52	.37	33.1	.....	.....
Average	.....	44	9.8	62.3	.53	.38	18.1	0.60	0.41
GROUP B.									
Massachusetts and New Hampshire.									
White Pine on a level plain site. Soil, a brown or yellow-brown loamy sand, underlaid by sand or sand with gravel in medium or sometimes coarse grain, shallow, porous, light, moderately loose, fresh, and well drained, with an abundant leafy surface cover. Trees, 350–400 to the acre.	28	41	6.8	43.8	0.47	0.42	5.6	.....	.....
	29	41	7.1	51.8	.51	.51	8.0	.....	.....
	7	39	8.3	52.0	.43	.40	8.8	.....	.....
	30	40	8.2	55.0	.51	.51	9.9	.....	.....
	8	40	9.1	58.2	.51	.36	13.0	.....	.....
	6	49	9.5	63.7	.51	.43	16.3	.....	.....
	12	49	10.2	68.0	.45	.47	16.6	.....	.....
	11	50	10.3	63.0	.50	.46	19.0	.....	.....
	4	54	11.2	59.0	.51	.37	19.7	.....	.....
	9	39	12.0	59.1	.48	.51	22.4	.....	.....
	10	51	12.5	69.9	.52	.41	31.3	.....	.....
	5	52	13.7	71.5	.51	.42	36.3	.....	.....
Average	.....	45	9.9	60.0	.50	.44	17.0	0.50	0.38
Pennsylvania.									
White Pine intermixed with hardwoods and occasional Hemlock. Soil, clayey loam, with yellow-brown shales in it, deep, fresh, and well drained.	3	46	12.0	60.0	0.43	0.62	20.2	.....	.....
	12	44	11.5	58.5	.47	.55	20.0	.....	.....
	2	44	12.5	55.0	.41	.67	19.4	.....	.....
	8	47	11.0	59.0	.48	.49	18.7	.....	.....
	16	47	11.5	56.0	.45	.50	18.3	.....	.....
	9	45	11.0	58.5	.49	.52	17.9	.....	.....
	5	47	10.5	60.0	.48	.43	17.3	.....	.....
	6	47	10.0	59.0	.51	.46	16.4	.....	.....
	21	48	10.5	58.0	.46	.48	16.3	.....	.....
	19	47	11.0	55.0	.42	.49	15.4	.....	.....
Average	.....	46	11.0	58.0	.45	.52	18.0	0.70	0.39
GROUP C.									
Maine.									
White Pine with scattering Hemlock, occasional Spruce and Fir, on a level plain site; scanty undergrowth of Hazel and young Hemlock. Soil, gray sand, sometimes brown or loamy, with 3 inches vegetable mold, deep, fresh, leafy surface cover; clayey subsoil probably 4 or 5 feet below surface. Density of crown cover, 0.7. Trees, 370 to the acre.	9	50	14.5	64	0.45	0.55	33.1	.....	.....
	4	59	13.3	60	.44	.58	26.4	.....	.....
	8	55	12.8	61	.45	.38	25.6	.....	.....
	3	50	11.8	58	.52	.41	20.1	.....	.....
	10	59	10.2	65	.59	.35	22.0	.....	.....
	12	50	11.0	62	.50	.35	21.1	.....	.....
Average	.....	54	12.3	62	.49	.44	24.7	0.91	0.46
Pennsylvania.									
From a young White Pine grove mixed with mature Spruce, Hemlock, and scattering hardwoods. Soil, fresh sand, well drained.	1	64	14.5	54	0.46	0.66	28.7	.....	.....
	2	57	14.5	58	.47	.66	31.4	.....	.....
	3	50	8.5	50	.48	.60	9.5	.....	.....
	4	47	8.0	46	.45	.61	7.3	.....	.....
	5	52	11.0	50	.43	.60	11.2	.....	.....
	6	49	11.5	46	.47	.61	15.7	.....	.....
	7	52	9.5	53	.46	.66	12.1	.....	.....
	8	54	8.0	54	.53	.66	10.1	.....	.....
	9	54	10.0	56	.48	.68	14.7	.....	.....
Average	.....	53	10.5	52	.47	.64	16.0	0.68	0.30
GROUP D.									
Wisconsin.									
An open grove of hardwoods, in which White Pine is scattered in varying proportions, on broken land, with frequent swamps in the hollows; undergrowth, of young hardwoods, Fir, few Hemlock, and Hornbeam. Soil light brown sandy loam, medium fine grain, loose, deep, fresh, and well drained, with an abundant leafy surface cover.	22	82	14.0	82	0.49	0.39	13.0	.....	.....
	23	81	14.7	84	.50	.42	18.0	.....	.....
	31	83	15.0	82	.48	.41	48.1	.....	.....
	27	79	15.0	83	.48	.31	50.8	.....	.....
	30	81	19.0	85	.46	.37	78.2	.....	.....
	33	89	18.7	96	.47	.51	85.7	.....	.....
Average	.....	82½	16.0	85	.48	.40	58.9	2.16	0.71

TABLE III.—*Measurements of White Pine grown under similar conditions, grouped in age classes for averaging*—Continued.

Group, location, and description of site.	Tree number.	Age.	Diameter with bark (breast high).	Total height.	Factor of shape.	Ratio of the length of crown to the total height of the tree.	Volume of boles.	Accretion,	
								Current annual.	Average annual.
GROUP E.									
Maine.									
		Yrs.	*Inches.*	*Feet.*			*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
White Pine with scattering Red and White Oak, and occasional Norway Pine, on a level; undergrowth, moderately dense, of small Hemlock and Beech, with numerous small Maple and Oak. Soil, gray or brown, fine, loamy sand, fresh, with 2 or 3 inches mold on top, and leafy surface cover; clay probably some feet below surface. Density of crown, 0.7. Trees, 126 to the acre.	7	98	28.0	100	0.41	0.60	175.3	.....	.....
	12	92	28.0	103	.36	.61	161.0	.....	.....
	13	98	25.0	92	.46	.48	140.3	.....	.....
	17	92	25.5	91	.42	.56	136.3	.....	.....
	18	92	25.0	88	.41	.46	131.7	.....	.....
	23	97	22.0	98	.46	.49	119.4	.....	.....
	21	97	20.6	102	.35	.45	118.1	.....	.....
	16	90	22.5	91	.46	.52	115.1	.....	.....
	9	102	20.0	100	.47	.43	104.0	.....	.....
	20	100	20.3	103	.41	.40	98.8	.....	.....
Average	.....	96	23.7	97	.42	.50	130.0	2.10	1.35
GROUP F.									
Maine.									
White Pine with scattering Red and White Oak, and occasional Norway Pine, on a level; undergrowth, moderately dense, of small Hemlock and Beech, with numerous small Maple and Oak. Soil, gray or brown, fine, loamy sand, fresh, with 2 or 3 inches mold on top, and leafy surface cover; clay probably some feet below surface. Density of crown cover, 0.7. Trees, 126 to the acre.	4	101	20.5	95	0.13	0.40	93.3	.....	.....
	8	98	19.5	99	.43	.33	88.4	.....	.....
	22	98	19.0	96	.45	.35	84.9	.....	.....
	10	89	16.8	99	.46	.40	71.3	.....	.....
	14	93	18.5	92	.41	.52	69.9	.....	.....
	28	93	18.5	80	.48	.41	68.4	.....	.....
	19	89	18.7	79	.45	.48	67.2	.....	.....
	15	99	17.2	87	.49	.46	67.0	.....	.....
	11	89	17.2	89	.43	.38	60.7	.....	.....
Average	.....	95	18.5	91	.45	.41	74.5	1.55	0.78
GROUP G.									
Michigan.									
Open grove on a level plain, along the banks of a river, of mixed White and Norway Pine, with scattering White Birch, and occasionally Oak, Hackmatack, and Banksian Pine; undergrowth scanty, of young Fir, Cedar (*Thuja occidentalis*), and few small Oaks. Soil, gray or light brown, sandy, medium fine-grained, porous light, loose, dry (in places fresh), with a leafy surface cover.	1	100	13.5	94	0.44	0.57	41.0	.....	.....
	24	96	14.4	90	.47	(?)	48.7	.....	.....
	18	82	16.5	94	.47	.53	65.7	.....	.....
	9	99	20.0	100	.41	.46	90.9	.....	.....
Average	.....	94	16.0	94½	.45	.51	61.5	2.13	0.65
GROUP H.									
Michigan.									
Open grove on a level plain, along the banks of a river, of mixed White and Norway Pine, with scattering White Birch, and occasionally Oak, Hackmatack, and Banksian Pine; undergrowth scanty, of young Fir, Cedar (*Thuja occidentalis*), and a few small Oaks. Soil, gray or light brown, sandy, medium, fine-grained, porous, light, loose, dry (in places fresh), with a leafy surface cover.	5	109	13.0	94½	.52	0.51	45.7	.....	.....
	23	112	14.0	96	.47	.47	50.2	.....	.....
	22	109	14.8	93	.45	.47	51.4	.....	.....
	15	106	15.3	85	.47	.37	53.3	.....	.....
	7	110	16.5	104	.41	.30	64.3	.....	.....
	6	109	17.0	101	.42	.59	67.6	.....	.....
	20	112	17.0	100	.45	(?)	72.4	.....	.....
	4	112	18.3	103	.44	.56	85.3	.....	.....
	19	108	20.5	105	.41	.49	99.1	.....	.....
	21	109	20.8	105	.39	.42	99.8	.....	.....
Average	.....	109½	16.7	98½	.44	.46	68.9	1.64	0.63
GROUP I.									
Michigan.									
Norway Pine (67 per cent), mixed with White Pine (32 per cent), and occasional Rock Maple, on a level plain. Soil, yellow or gray sand, fresh, moderately loose, with a surface cover of brakes; subsoil, sandy. Density of crown cover, 0.7. Trees, 182 to the acre.	1	123	20.0	102	0.40	0.54	89.7	.....	.....
	22	101	20.8	90	.42	.51	92.7	.....	.....
	48	105	20.5	99	.42	.44	96.7	.....	.....
	47	104	22.7	94	.39	.59	103.0	.....	.....
Average	.....	108	21.0	96	.41	.51	95.5	1.81	0.89
GROUP K.									
Wisconsin.									
An open grove of hardwoods, in which White Pine is scattered in varying proportions, on broken land, with frequent swamps in the hollows; undergrowth, of young hardwoods, Fir, few Hemlock, and Hornbeam. Soil, light-brown sandy loam, medium fine grain, loose, deep, fresh, and well drained, with an abundant leafy surface cover.	14	121	20.2	91	0.45	0.50	90.9	.....	.....
	28	125	24.5	89	.45	.58	131.8	.....	.....
	15	125	26.5	96	.39	.46	141.5	.....	.....
	16	125	26.3	105	.47	.53	176.8	.....	.....
	17	119	29.0	97	.42	.57	189.5	.....	.....
Average	.....	123	25.3	95	.44	.53	145.5	2.92	1.19

TABLE III.—*Measurements of White Pine grown under similar conditions, grouped in age classes for averaging*—Continued.

Group, location, and description of site.	Tree number.	Age.	Diameter with bark (breast high).	Total height.	Factor of shape.	Ratio of the length of crown to the total height of the tree.	Volume of boles.	Accretion.	
								Current annual.	Average annual.
GROUP L.									
Michigan.									
		Yrs.	*Inches*	*Feet*			*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
White Pine (70 per cent) intermixed with Norway Pine (14 per cent) and Hemlock (15 per cent), with scattering Cedar (*Thuja occidentalis*) and Rock Maple, and occasional Beech and White Birch, on a level plain; undergrowth, dense, of young Fir. Soil, gray sand, fresh and deep, light and loose, with a surface cover of scanty leaves; subsoil, sandy loam, underlaid by clay. Density of crown, 0.8. Trees, 156 to the acre.	34	140	19.5	124	0.42	0.34	109.8	.....	.....
	9	136	19.7	114	.49	.34	115.1	.....	.....
	33	135	20.0	115	.48	.32	121.5	.....	.....
	37	134	22.0	113	.41	.27	123.5	.....	.....
	36	136	22.5	123	.39	.30	130.1	.....	.....
	35	135	21.7	122	.44	.32	136.1	.....	.....
	2	138	22.8	119	.40	.30	138.5	.....	.....
	22	133	23.2	116	.42	.38	141.1	.....	.....
	4	130	24.0	106	.43	.40	143.5	.....	.....
	3	135	24.0	108	.42	.35	141.7	.....	.....
	1	138	23.5	113	.43	.26	146.5	.....	.....
	16	139	25.0	122	.44	.50	187.3	.....	.....
Average		136	22.3	116	.42	.34	136.0	1.60	1.00
GROUP M.									
Michigan.									
A two roof grove, upper roof formed of White Pine, under roof of Beech, Maple, Fir, and occasionally White Birch and Hemlock; undergrowth, moderately dense, of young hardwoods and Fir. Soil, brown loamy sand, fresh, moderately loose, with a surface cover of brakes and grass; subsoil, sand with stones.	32	133	15.2	92	0.43	0.43	48.6	.....	.....
	37	141	15.5	92	.46	.42	55.3	.....	.....
	12	132	16.3	88	.47	.66	61.7	.....	.....
	40	145	18.6	100	.38	.44	71.1	.....	.....
	25	128	20.5	98	.42	.47	94.6	.....	.....
	27	153	19.0	104	.45	.38	85.0	.....	.....
	9	131	22.5	112	.41	.46	129.1	.....	.....
	26	148	23.0	116	.41	.46	137.9	.....	.....
	31	153	23.0	109	.47	.30	137.6	.....	.....
	11	136	24.6	115	.41	.40	154.1	.....	.....
Average		140	19.8	102	.43	.44	95.3	1.49	0.70
GROUP N.									
Michigan.									
Norway Pine (67 per cent) mixed with White Pine (32 per cent), and occasional Rock Maple, on a level plain. Soil, yellow or gray sand, fresh, moderately loose, with a surface cover of brakes; subsoil, sandy. Density of crown cover, 0.7. Trees, 182 to the acre.	5	149	20.2	105	0.39	0.50	88.9	.....	.....
	6	135	21.1	114	.39	.57	107.9	.....	.....
	35	135	22.0	121	.40	.43	139.6	.....	.....
Average		140	21.0	113	.39	.50	112.1	2.08	0.80
GROUP O.									
Michigan.									
White Pine (70 per cent) intermixed with Norway Pine (14 per cent) and Hemlock (15 per cent), with scattering Cedar (*Thuja occidentalis*) and Rock Maple, and occasional Beech and White Birch, on a level plain; undergrowth dense, of young Fir. Soil, gray sand, fresh and deep, light and loose, with a surface cover of scanty leaves; subsoil, sandy loam, underlaid by clay. Density of crown cover, 0.8. Trees, 156 to the acre.	27	142	23.0	117	0.41	0.30	138.9	.....	.....
	26	142	24.0	110	.41	.39	140.6	.....	.....
	11	142	23.5	111	.43	.36	148.0	.....	.....
	20	142	22.0	119	.49	.26	157.3	.....	.....
	30	143	24.2	116	.45	.38	164.3	.....	.....
	24	149	25.0	113	.46	.34	168.8	.....	.....
	5	148	26.3	115	.46	.39	205.4	.....	.....
Average		142	24.0	115	.44	.34	160.5	2.20	1.10
GROUP P.									
Wisconsin.									
White Pine mixed more or less with Yellow Birch, Rock Maple, Norway Pine, and occasional Bass, Poplar, and Elm, on uneven land, full of drift ridges and hollows, frequently full of water. Soil, a mixture of loam, sand, and stones, with 2 to 3 inches black mold on top, and fairly covered with leaves.	3	160	23.5	104	0.40	0.40	127	.....	.....
	4	170	24.0	119	.46	.41	172	.....	.....
	5	178	24.2	114	.48	.38	176	.....	.....
	6	170	25.7	111	.45	.41	181	.....	.....
	7	175	27.3	122	.47	.46	217	.....	.....
	8	168	30.5	114	.44	.42	256	.....	.....
	15	185	23.2	110	.42	.34	138	.....	.....
	9	173	26.0	112	.46	.28	190	.....	.....
Average		172	25.5	113	.44	.39	182	1.44	1.00
GROUP Q.									
Michigan.									
Norway Pine intermixed with White Pine in varying proportions, on rolling land, with open places of Red Oak, Maple, and Beech; no undergrowth. Soil, light brown sand (slightly loamy), very deep, medium fine, light, loose, dry, and well drained, with a moderately leafy surface cover.	34	182	25.2	118	0.43	0.53	173.0	.....	.....
	18	188	26.7	118	.45	.59	202.1	.....	.....
	5	186	31.0	119	.45	.40	286.6	.....	.....
Average		185	27.6	118	.44	.51	220.5	2.22	1.19

TABLE III.—*Measurements of White Pine grown under similar conditions, grouped in age classes for averaging*—Continued.

Group, location, and description of site.	Tree number.	Age.	Diameter with bark (breast high).	Total height.	Factor of shape.	Ratio of the length of crown to the total height of the tree.	Volume of boles.	Accretion.	
								Current annual	Average annual.
GROUP R.									
Wisconsin.		*Yrs.*	*Inches.*	*Feet.*			*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
White Pine intermixed with Yellow Birch, Rock Maple, Bass, and Norway Pine, on ridge land, with hollows sometimes full of water, more often open grassy swamps, with Alder and Hackmatack, fringed by pine. Soil, red clayey loam, mixed with sand and stones of all sizes, moist; subsoil, sometimes of clay, sometimes of sand.	1	204	27.3	123	0.44	0.59	219	.....	.....
	2	210	25.2	137	.48	.40	227	.....	.....
	3	207	31.0	127	.37	.35	246	.....	.....
	4	200	29.5	116	.43	.51	239	.....	.....
	5	206	29.2	130	.46	.29	282	.....	.....
	6	205	30.0	133	.43	.52	284	.....	.....
	7	210	34.0	118	.39	.37	292	.....	.....
	8	214	36.0	113	.39	.38	312	.....	.....
	9	210	39.0	130	.38	.49	415	.....	.....
Average	.....	207	31.2	125	.42	.43	279	1.67	1.34
GROUP S.									
Wisconsin.									
White Pine intermixed with Yellow Birch, Rock Maple, Bass, and Norway Pine, on ridge land, with hollows sometimes full of water, more often open grassy swamps, with Alder and Hackmatack, fringed by pine. Soil, red clayey loam, mixed with sand and stones of all sizes, moist; subsoil, sometimes of clay, sometimes of sand.	10	211	20.2	116	0.51	0.64	132	.....	.....
	11	228	23.6	113	.43	.42	148	.....	.....
	12	220	22.8	121	.45	.45	153	.....	.....
	13	207	27.2	107	.46	.28	200	.....	.....
	14	204	27.0	121	.42	.43	204	.....	.....
	15	205	27.0	122	.43	.25	210	.....	.....
	16	212	27.[illegible]	104	.41	.51	180	.....	.....
	17	204	27.3	112	.41	.41	186	.....	.....
Average	.....	211	25.4	114	.44	.42	176.5	0.88	0.83
GROUP T.									
Wisconsin.									
White Pine mixed with hardwoods, on drift and somewhat uneven land; undergrowth, of young hardwoods and Fir. Soil, clayey, underlaid by a hardpan of clay and stones, fresh with 4-inch mold on top.	1	204	24.7	102	0.49	0.45	166	.....	.....
	2	221	27.0	113	.41	.38	183	.....	.....
	3	213	27.0	121	.39	.37	191	.....	.....
	4	214	26.0	126	.43	.41	201	.....	.....
	5	216	26.8	126	.42	.40	210	.....	.....
	6	202	24.0	134	.44	.42	187	.....	.....
	7	204	29.0	132	.39	.37	238	.....	.....
	8	212	29.0	133	.41	.39	250	.....	.....
	9	213	30.0	133	.41	.42	291	.....	.....
Average	.....	211	27.0	124	.42	.44	213	1.49	1.00
GROUP U.									
Wisconsin.									
White Pine mixed more or less with Yellow Birch, Rock Maple, Norway Pine, and occasional Bass, Poplar, and Elm, on uneven land, full of drift ridges and hollows, frequently full of water. Soil, a mixture of loam, sand, and stones, with 2 to 3 inches black mold on top, and fairly covered with leaves.	10	216	31.8	121	0.43	0.40	287	.....	.....
	11	222	35.0	123	.42	.46	344	.....	.....
	12	228	24.8	116	.41	.40	160	.....	.....
	13	220	24.0	100	.49	.27	156	.....	.....
	16	220	24.5	107	.45	.35	157	.....	.....
	17	218	29.0	118	.44	.49	249	.....	.....
Average	.....	221	28.2	114	.44	.39	224	1.57	1.01
GROUP V.									
Michigan.									
A two-roof grove, upper roof formed of White Pine, under roof of Beech, Maple, Fir, and occasionally White Birch and Hemlock; undergrowth, moderately dense, of young hardwoods and Fir. Soil, brown loamy sand, fresh, moderately loose, with a surface cover of brakes and grass; subsoil, sand with stones.	41	245	20.0	120	0.43	0.16	112.56	.....	.....
	8	242	24.5	137	.42	.41	191.07	.....	.....
	30	226	27.5	138	.38	(?)	215.24	.....	.....
	1	226	27.5	129	.41	.38	222.24	.....	.....
	28	220	28.3	143	.42	.60	264.49	.....	.....
	34	250	30.2	141	.42	.31	291.03	.....	.....
	10	219	33.0	121	.44	.43	317.85	.....	.....
	33	226	33.0	140	.38	.49	321.86	.....	.....
	39	237	33.0	144	.45	.77	389.57	.....	.....
	29	233	37.0	147	.41	.55	455.05	.....	.....
	3	245	40.0	125	.43	.40	479.51	.....	.....
Average	.....	233	30.3	135	.41	.48	296.6	1.05	1.27
GROUP W.									
Michigan.									
A two-roof grove, upper roof formed by White Pine (80 per cent) and Norway Pine (20 per cent), under roof of fine, tall Hemlock; undergrowth, of young Hemlock, Beech, and Dwarf Maple. Soil, brown loamy sand, deep, fine (for sand), porous, loose, and well drained (water stands in low ground), with a moderately leafy surface cover; subsoil, same as soil.	3	234	23.2	137	0.43	0.39	169.0	.....	.....
	2	236	23.8	142	.44	.43	197.3	.....	.....
	11	235	24.5	142	.43	.43	199.1	.....	.....
	1	237	23.5	140	.46	.36	202.6	.....	.....
	6	237	24.5	145	.43	.40	205.4	.....	.....
	20	251	27.0	120	.43	.36	206.8	.....	.....
	17	232	24.5	145	.43	.47	207.0	.....	.....
	10	233	25.5	143	.42	.42	212.6	.....	.....
	16	237	25.5	145	.44	.44	227.3	.....	.....
	15	235	26.0	143	.43	.23	231.1	.....	.....
	18	245	30.0	122	.39	.35	233.9	.....	.....
	9	236	26.2	145	.44	.42	240.2	.....	.....
	4	230	27.0	150	.45	.41	271.5	.....	.....
	8	238	29.0	140	.43	.40	281.1	.....	.....
	19	244	34.0	130	.42	.62	348.1	.....	.....
	12	233	32.0	144	.43	.39	349.6	.....	.....
Average	.....	237½	26.5	140	.43	.41	236.4	1.64	0.99

TABLE III.—*Measurements of White Pine grown under similar conditions, grouped in age classes for averaging*—Continued.

Group, location, and description of site.	Tree number.	Age.	Diameter with bark (breast high).	Total height.	Factor of shape.	Ratio of the length of crown to the total height of the tree.	Volume of boles.	Accretion.	
								Current annual.	Average annual.
GROUP X.									
Michigan.									
		Yrs.	*Inches.*	*Feet.*			*Cubic ft.*	*Cubic ft.*	*Cubic ft*
A two roof grove, upper roof formed of White Pine, under roof of Beech, Maple, Fir, and occasionally White Birch and Hemlock; undergrowth, moderately dense, of young hardwoods and Fir. Soil, brown loamy sand, fresh, moderately loose, with a surface cover of brakes and grass; subsoil, sand with stones.	11	258	26.0	119	0.37	0.40	162.54	.....	.....
	7	252	29.2	139	.41	.46	193.21	.....	.....
	38	252	25.5	157	.35	.58	205.21	.....	.....
	23	265	27.0	126	.41	.44	207.67	.....	.....
	13	253	30.0	135	.39	.45	259.13	.....	.....
	36	256	32.0	142	.34	.59	267.87	.....	.....
	4	260	31.5	132	.38	.48	275.89	.....	.....
	42	260	29.5	155	.42	.48	311.99	.....	.....
	16	251	33.0	144	.35	.41	313.07	.....	.....
	2	256	31.0	145	.41	.39	314.06	.....	.....
	35	265	31.5	144	.40	.33	314.38	.....	.....
	6	266	33.0	139	.38	.51	316.81	.....	.....
	15	256	32.0	154	.41	.33	360.75	.....	.....
	5	258	34.0	138	.42	.59	370.50	.....	.....
	17	260	36.0	149	.37	.45	404.18	.....	.....
Average		258	30.5	141	.39	.46	285.00	1.50	1.10
GROUP Y.									
Michigan.									
Moderately dense grove of White Pine intermixed with hardwoods and Hemlock, with occasional Norway Pine, on a level plain; undergrowth, of young Hemlock and hardwoods. Soil, brown loamy sand, medium fine grain, light, loose, very deep, fresh, well drained, with a moderately leafy surface cover.	5	417	37.0	155	0.37	0.45	433.2	.....	.....
	1	445	35.5	141	.52	.39	510.5	.....	.....
	4	435	41.0	152	.41	.53	583.7	.....	.....
	9	426	43.0	160	.42	.56	677.3	.....	.....
	8	460	46.0	150	.40	.48	694.1	.....	.....
	7	457	47.0	160	.37	.45	721.9	.....	.....
	3	461	48.0	170	.38	.56	737.9	.....	.....
	6	435	46.0	168	.42	.51	819.6	.....	.....
	10	458	47.0	162	.43	.57	855.3	.....	.....
Average		446	43.0	157	.41	.50	670.4	2.60	1.50
GROUP Z.									
Pennsylvania.									
Hemlock mixed with White Pine, with scattering hardwoods; undergrowth, moderately dense, of young hardwoods and Hemlock. Soil, yellow clay loam of a medium grain, deep, fresh, well drained, with 2 to 3 inches mold on top, and a surface cover of scanty leaves, Fern and Teaberries.	1	260	35.5	158	0.40	0.43	435.4	.....	.....
	2	260	36.0	157	.43	.42	481.3	.....	.....
	3	259	32.0	152	.46	.44	396.0	.....	.....
	4	241	32.0	150	.41	.59	347.7	.....	.....
	10	244	33.0	146	.42	.34	365.9	.....	.....
	12	262	28.0	156	.43	.43	285.8	.....	.....
	18	265	39.0	153	.40	.42	511.1	.....	.....
	19	250	34.0	150	.42	.48	402.4	.....	.....
	20	266	44.0	144	.42	.30	638.4	.....	.....
	21	245	34.0	146	.40	.37	366.7	.....	.....
	23	248	34.0	142	.42	.37	373.4	.....	.....
	33	259	33.0	133	.40	.31	304.5	.....	.....
	34	262	33.0	146	.42	.38	369.2	.....	.....
	35	263	31.0	144	.36	.43	275.2	.....	.....
	36	241	31.5	131	.42	.34	307.7	.....	.....
	37	261	37.0	146	.44	.27	482.9	.....	.....
Average		255	34.0	147	.41	.39	390.0	2.16	1.53

TABLE IV.—*Dimensions, volume, and rate of growth, by decades, based upon analyses of trees in Tables III and VI.*

(A) OLD-GROWTH PINE.

(1) DOMINANT TREES.

Average throughout the range.]

(224 trees.)

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodic accretion.			Average annual accretion.	Current annual accretion.
				Heartwood.	Sapwood.	Bark.	Decade.	Height.	Volume.		
Years.	*Inches.*	*Feet.*	*Cubic ft.*	*Per cent.*	*Per cent.*	*Per cent.*		*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
10	0.9	7.7	(1)	.....	.....	.....	1	7.7	(1)	(1)	(1)
20	2.5	21.0	0.5	.....	.....	.....	2	13.3	(1)	0.02	(1)
30	4.8	33.7	2.2	.....	.....	.....	3	12.7	1.7	.07	0.17
40	6.9	46.0	5.6	.....	.....	.....	4	12.3	3.4	.13	.34
50	8.7	56.7	10.8	40	47	13	5	10.7	5.2	.22	.52
60	10.5	66.3	18.6	.....	.....	.....	6	9.7	7.7	.31	.77
70	12.1	74.7	28.0	.....	.....	.....	7	8.3	9.5	.40	.95
80	13.8	82.0	38.8	.....	.....	.....	8	7.3	10.8	.49	1.08
90	15.5	89.0	50.9	.....	.....	.....	9	7.0	12.1	.56	1.21
100	17.2	91.3	66.0				10	5.7	15.1	.66	1.51
110	18.9	99.0	82.7	55	33	12	11	4.3	16.7	.75	1.67
120	20.6	103.7	100.3				12	4.7	17.6	.84	1.76
130	22.2	107.7	118.5	.....	.....	.....	13	4.0	18.2	.91	1.82
140	23.7	111.3	137.3	.....	.....	.....	14	3.7	18.8	.98	1.88
150	25.0	114.4	155.7	.....	.....	.....	15	3.0	18.4	1.04	1.84
160	26.3	117.3	175.3	.....	.....	.....	16	3.0	19.6	1.09	1.96
170	27.5	120.7	194.6	.....	.....	.....	17	3.3	19.3	1.14	1.93
180	28.7	123.7	214.8	.....	.....	.....	18	3.0	20.2	1.19	2.02
190	29.8	126.3	234.7	.....	.....	.....	19	2.7	19.9	1.23	1.99
200	31.0	129.0	254.7	65	23	12	20	2.7	20.0	1.27	2.00
210	30.7	134.5	.....	.....	.....	.....	21	3.0	20.6	1.25	2.06
220	31.6	137.5	.....	.....	.....	.....	22	3.0	21.5	1.30	2.15
230	32.0	140.5	.....	69	21	11	23	3.0	21.6	1.34	2.16

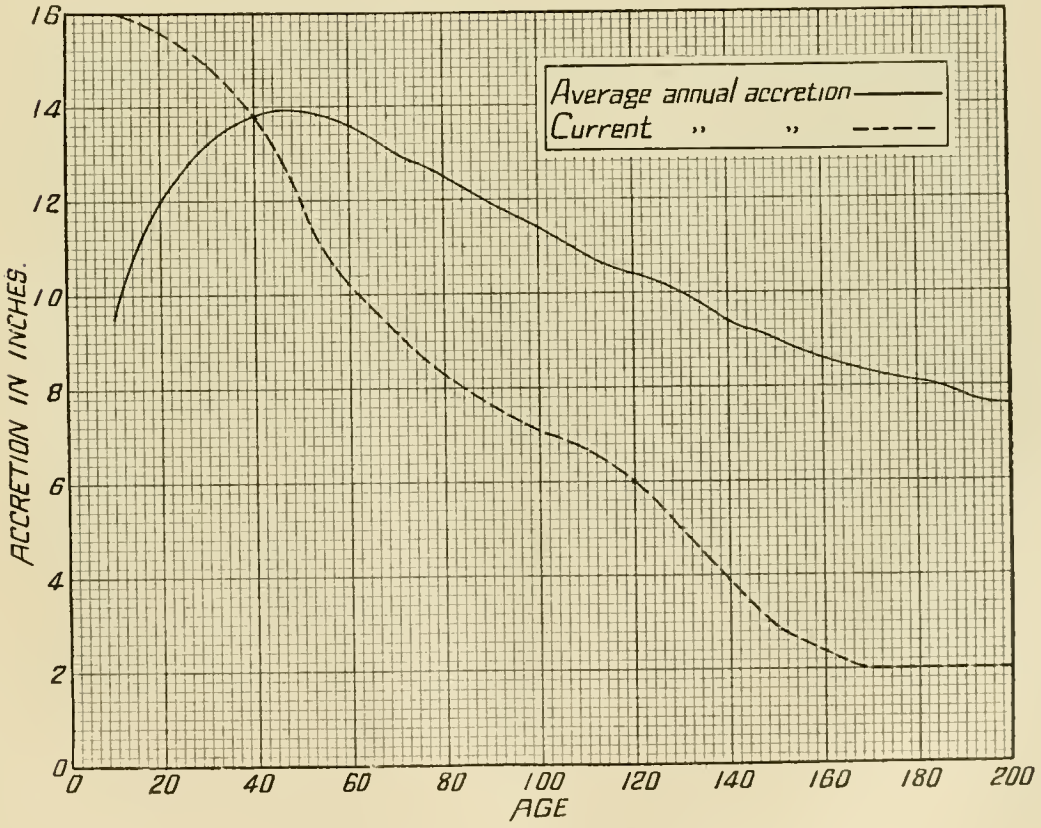


FIG. 19.—Diagram showing rate of height growth of dominant trees.

TABLE IV.—*Dimensions, volume, and rate of growth, by decades, etc.*—Continued.

(A) OLD-GROWTH PINE—Continued.

(2) CODOMINANT TREES.

[Average throughout the range.]

(106 trees.)

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodic accretion.			Average annual accretion.	Current annual accretion.
				Heart wood.	Sapwood	Bark.	Decade.	Height.	Volume.		
Years.	*Inches.*	*Feet.*	*Cubic ft.*	*Per cent.*	*Per cent.*	*Per cent.*		*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
10	0.8	6.0	(1)	.....	.....	.....	1	6.0	(1)	(1)	(1)
20	2.3	16.0	0.4	.....	.....	.....	2	10.0	(1)	0.02	(1)
30	4.0	28.5	1.6	.....	.....	.....	3	12.0	1.2	.05	0.12
40	5.8	38.0	4.4	.....	.....	.....	4	9.5	2.9	.11	.29
50	7.5	47.5	7.7	.....	.....	.....	5	9.5	3.3	.15	.33
60	9.0	56.5	11.3	.....	.....	.....	6	9.0	3.6	.19	.36
70	10.5	64.0	17.4	.....	.....	.....	7	7.5	6.1	.25	.61
80	11.9	71.5	24.9	.....	.....	.....	8	7.5	7.5	.31	.75
90	13.3	79.0	34.4	.....	.....	.....	9	7.5	9.5	.38	.95
100	14.7	84.5	44.5	.....	.....	.....	10	5.5	10.2	.45	1.02
110	16.0	89.5	55.5	.....	.....	.....	11	5.0	11.0	.50	1.10
120	17.3	94.5	67.5	.....	.....	.....	12	5.0	12.0	.56	1.20
130	18.6	99.0	78.6	.....	.....	.....	13	4.5	11.2	.61	1.12
140	19.8	103.0	91.5	.....	.....	.....	14	4.0	12.9	.66	1.29
150	20.8	107.0	104.0	.....	.....	.....	15	4.0	12.5	.69	1.25
160	22.0	111.0	115.9	.....	.....	.....	16	4.0	12.0	.72	1.20
170	23.0	114.0	127.7	.....	.....	.....	17	3.0	11.8	.75	1.18
180	23.8	117.5	129.2	.....	.....	.....	18	3.5	13.9	.72	1.39
190	24.7	120.0	142.9	.....	.....	.....	19	2.5	13.7	.75	1.37
200	25.6	122.5	152.7	.....	.....	.....	20	2.5	9.8	.76	.98
210	26.3	125.0	165.5	.....	.....	.....	21	2.5	12.8	.79	1.28
220	27.0	127.5	179.3	.....	.....	.....	22	2.5	13.8	.81	1.38
230	27.7	130.0	195.0	.....	.....	.....	23	2.5	15.7	.84	1.57

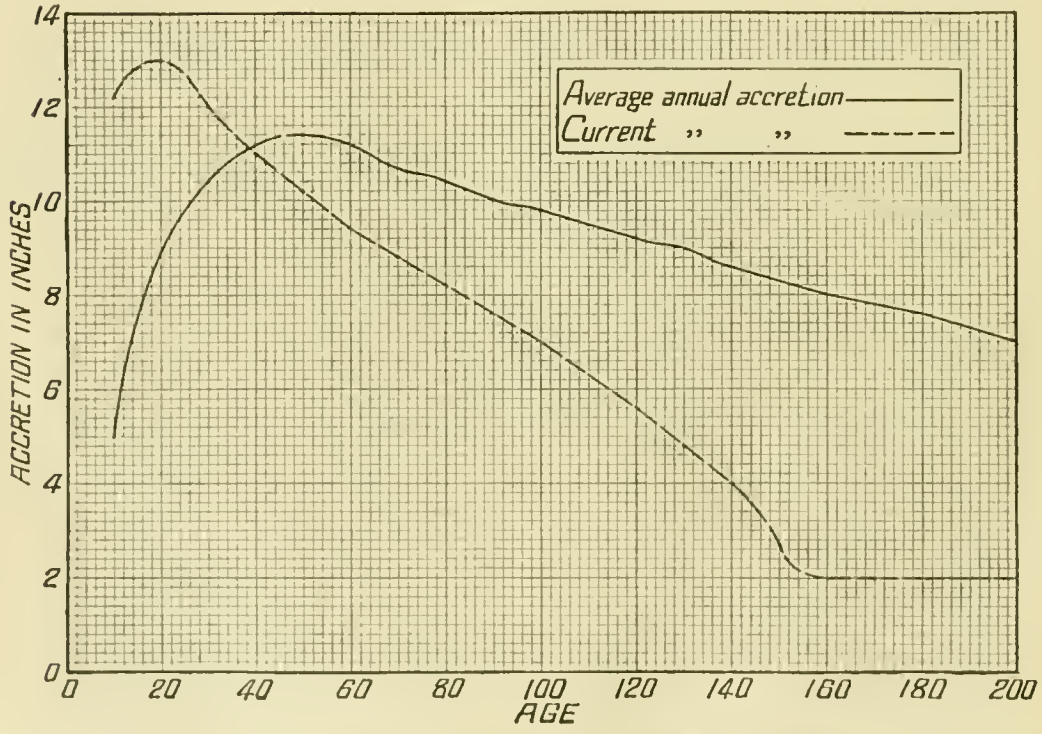


FIG. 20.—Diagram showing rate of height growth of codominant trees

TABLE IV.—*Dimensions, volume, and rate of growth, by decades, etc.*—Continued.

(A) OLD-GROWTH PINE—Continued.

(3) OPPRESSED TREES.

[Average throughout the range.]

(104 trees.)

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodic accretion.			Average annual accretion.	Current annual accretion.
				Heartwood.	Sapwood.	Bark.	Decade.	Height.	Volume.		
Years.	*Inches.*	*Feet.*	*Cubic ft.*	*Per cent.*	*Per cent.*	*Per cent.*		*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
10	0.9	4.0	(1)	.....	.....	.....	1	4.0	(1)	(1)	(1)
20	2.0	11.0	0.4	.....	.....	.....	2	7.0	(1)	0.02	(1)
30	3.7	18.0	0.7	.....	.....	.....	3	7.0	0.4	.02	0.04
40	5.2	26.0	1.7	.....	.....	.....	4	8.0	1.0	.04	.10
50	6.7	34.5	3.6	.....	.....	.....	5	8.5	1.9	.07	.19
60	8.0	43.5	6.5	.....	.....	.....	6	9.0	2.9	.11	.29
70	9.2	51.5	10.3	.....	.....	.....	7	8.0	3.8	.15	.38
80	10.6	59.5	15.1	.....	.....	.....	8	8.0	4.8	.19	.48
90	11.9	66.5	20.5	.....	.....	.....	9	7.0	6.5	.24	.65
100	13.3	73.0	29.0	51	36	13	10	6.5	7.5	.29	.75
110	14.7	79.0	37.5				11	6.0	8.5	.35	.85
120	15.9	84.5	46.8				12	5.5	9.3	.39	.93
130	17.1	89.0	57.0	.....	.....	.....	13	4.5	10.3	.44	1.03
140	18.2	93.5	68.5	.....	.....	.....	14	4.5	11.5	.49	1.15
150	19.3	97.0	79.5	.....	.....	.....	15	3.5	11.0	.54	1.10
160	20.3	100.5	90.8	.....	.....	.....	16	3.5	11.3	.57	1.13
170	21.2	103.5	102.3	.....	.....	.....	17	3.0	11.5	.60	1.15
180	22.2	106.5	114.0	.....	.....	.....	18	3.0	11.8	.64	1.18
190	23.2	109.0	125.0	.....	.....	.....	19	2.5	11.0	.66	1.10
200	23.9	111.5	136.0	60	28	12	20	2.5	11.0	.68	1.10

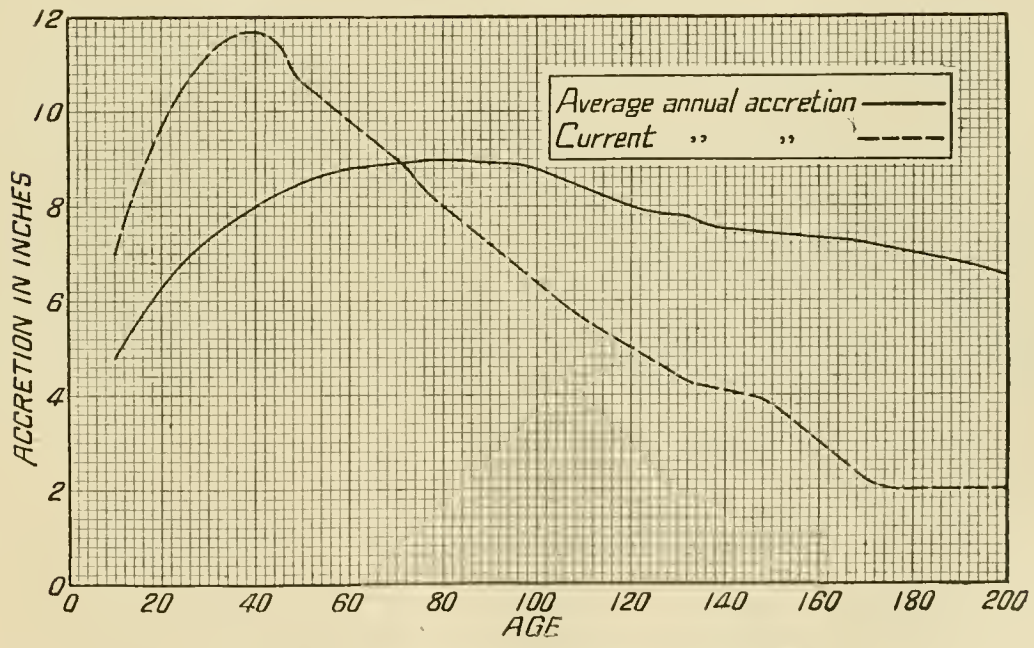


FIG. 21.—Diagram showing rate of height growth of oppressed trees.

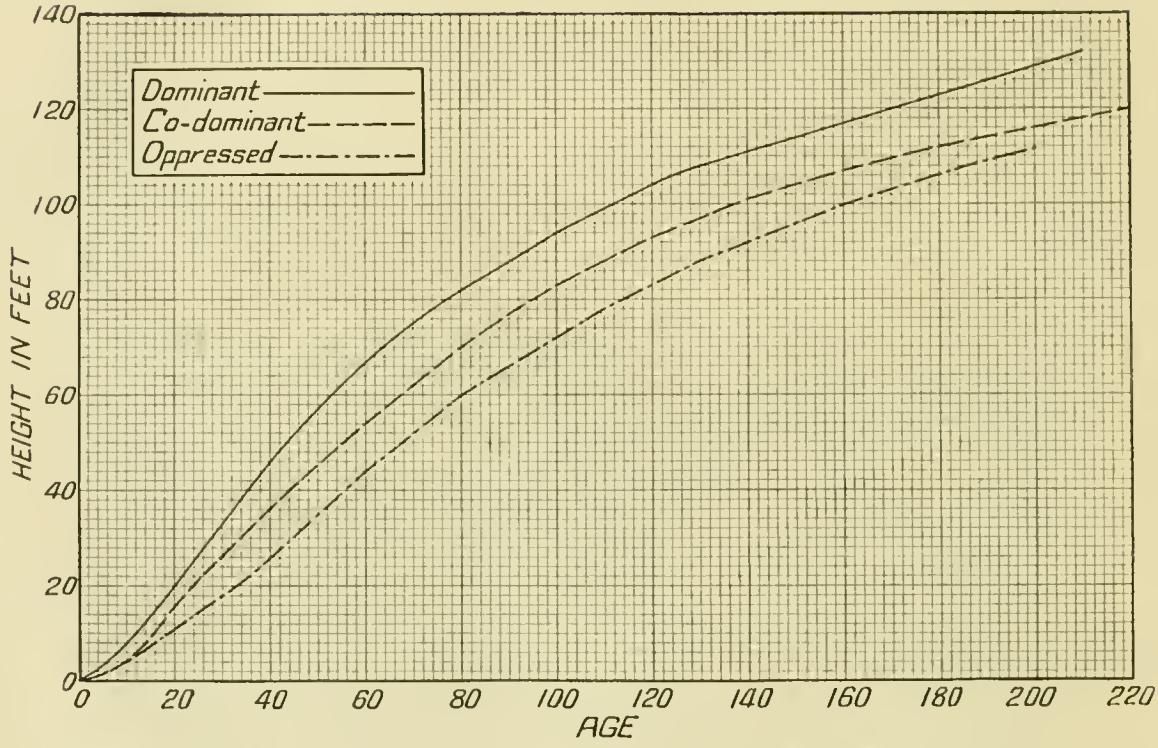


FIG. 22.—Diagram showing height growth of dominant, codominant, and oppressed trees throughout range.

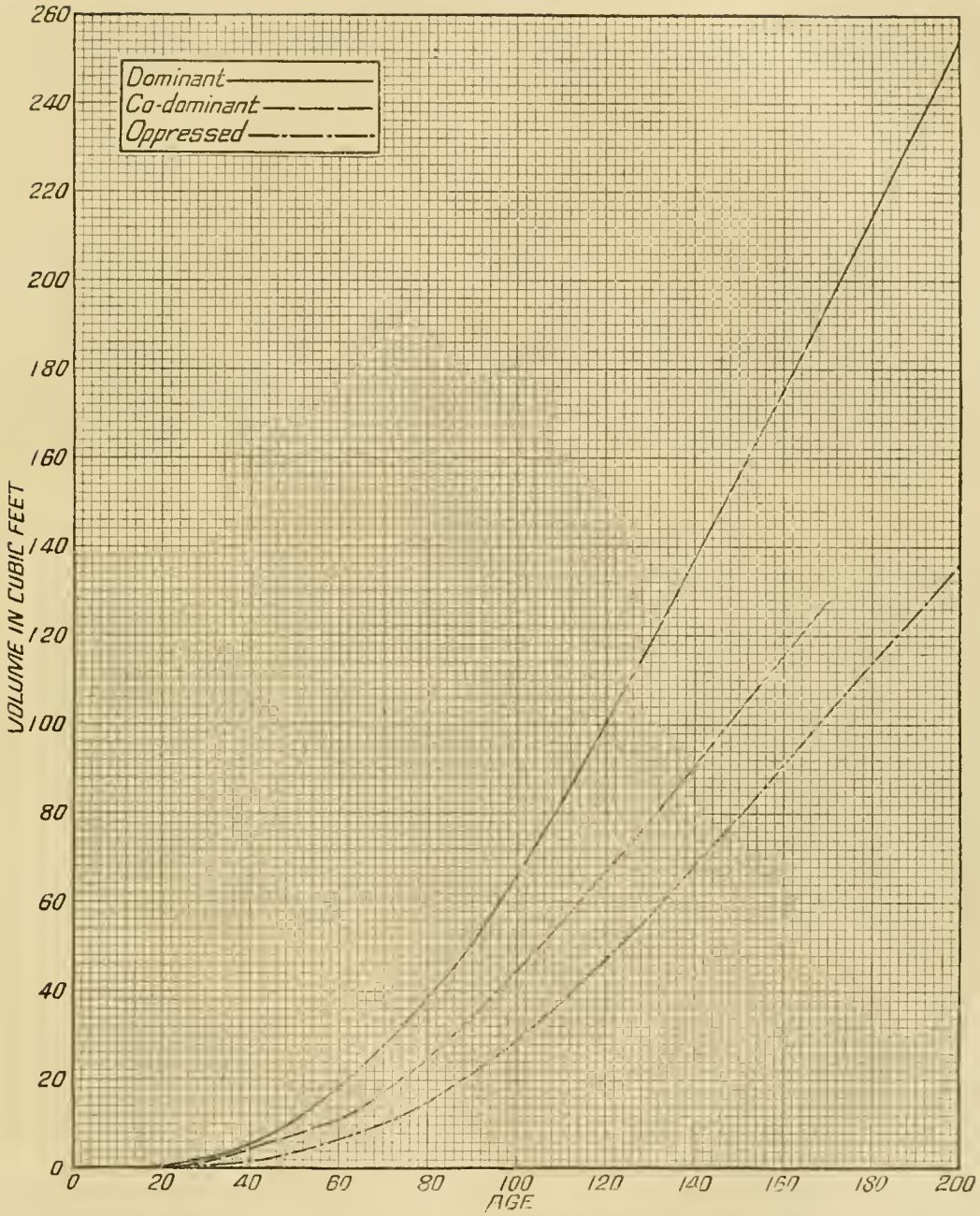


FIG. 23.—Diagram showing volume growth of dominant, codominant, and oppressed trees throughout range.

TABLE IV.—*Dimensions, volume, and rate of growth, by decades, etc.*—Continued.

(4) OLD GROWTH PINE—Continued.

(4) DOMINANT TREES.

[Average in Wisconsin.]

(68 trees.)

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodic accretion.			Average annual accretion.	Current annual accretion.
				Heartwood.	Sapwood	Bark.	Decade.	Height.	Volume.		
Years.	*Inches.*	*Feet.*	*Cubic ft.*	*Per cent.*	*Per cent.*	*Per cent.*		*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
10	1.0	9	(?)	.....	.....	.....	1	9	(?)	(?)	(?)
20	2.2	22	0.5	.....	.....	.....	2	13	(?)	0.02	(?)
30	3.8	34	1.9	.....	.....	.....	3	12	1.4	.06	0.14
40	5.3	46	3.5	.....	.....	.....	4	12	1.6	.02	.16
50	6.6	57	7.6	.....	.....	.....	5	11	4.1	.15	.41
60	8.0	66	13.2	.....	.....	.....	6	9	5.6	.22	.56
70	9.3	74	21.0	.....	.....	.....	7	8	7.8	.30	.78
80	11.0	80	30.0	.....	.....	.....	8	6	9.0	.38	.90
90	13.0	86	41.5	.....	.....	.....	9	6	11.5	.46	1.15
100	15.2	91	58.0	.....	.....	.....	10	5	16.5	.58	1.65
110	17.4	95	78.0	.....	.....	.....	11	4	20.0	.71	2.00
120	19.6	100	100.5	.....	.....	.....	12	5	22.5	.84	2.25
130	21.8	104	124.0	.....	.....	.....	13	4	23.5	.95	2.35
140	24.0	108	147.5	.....	.....	.....	14	4	23.5	1.05	2.35
150	25.7	111	169.0	.....	.....	.....	15	3	24.5	1.13	2.15
160	27.4	114	190.5	.....	.....	.....	16	3	21.5	1.19	2.15
170	29.0	117	212.5	.....	.....	.....	17	3	22.0	1.25	2.20
180	30.5	120	234.5	.....	.....	.....	18	3	22.0	1.30	2.20
190	32.0	122	256.0	.....	.....	.....	19	2	21.5	1.35	2.15
200	33.3	124	277.0	65	23	12	20	2	21.0	1.38	2.10

(5) OPPRESSED TREES.

[Average in Wisconsin.]

(55 trees.)

10	1.0	4	(?)	.....	.....	.....	1	4	(?)	(?)	(?)
20	2.2	10	0.4	.....	.....	.....	2	6	(?)	0.02	(?)
30	4.0	16	.7	.....	.....	.....	3	6	0.3	.02	0.03
40	5.4	24	1.6	.....	.....	.....	4	8	.9	.04	.09
50	6.8	32	3.2	.....	.....	.....	5	8	1.6	.06	.16
60	8.0	40	6.0	.....	.....	.....	6	8	2.8	.10	.28
70	9.2	47	9.5	.....	.....	.....	7	7	3.5	.13	.35
80	10.6	55	13.5	.....	.....	.....	8	8	4.0	.17	.40
90	12.0	62	20.0	.....	.....	.....	9	7	6.5	.22	.65
100	13.4	69	28.0	.....	.....	.....	10	7	8.0	.28	.80
110	14.7	75	38.0	.....	.....	.....	11	6	10.0	.35	1.00
120	16.0	81	48.5	.....	.....	.....	12	6	10.5	.40	1.05
130	17.2	86	60.0	.....	.....	.....	13	5	11.5	.46	1.15
140	18.3	90	73.0	.....	.....	.....	14	4	13.0	.52	1.30
150	19.5	94	85.0	.....	.....	.....	15	4	12.0	.57	1.20
160	20.6	98	97.5	.....	.....	.....	16	4	12.5	.61	1.25
170	21.6	101	109.5	.....	.....	.....	17	3	12.0	.64	1.20
180	22.7	104	122.0	.....	.....	.....	18	3	12.5	.68	1.25
190	23.7	107	134.0	.....	.....	.....	19	3	12.0	.70	1.20
200	24.6	110	146.0	60	28	12	20	3	12.0	.73	1.20

(6) DOMINANT TREES.

[Average in Michigan.]

(75 trees.)

10	0.8	7	(?)	.....	.....	.....	1	7	(?)	(?)	(?)
20	2.6	20	0.5	.....	.....	.....	2	13	(?)	0.02	(?)
30	5.2	32	2.0	.....	.....	.....	3	12	1.5	.07	0.15
40	7.4	43	5.5	.....	.....	.....	4	11	3.5	.16	.35
50	9.4	53	10.5	.....	.....	.....	5	10	5.0	.21	.50
60	11.3	63	17.6	.....	.....	.....	6	10	7.1	.29	.71
70	13.1	72	27.0	.....	.....	.....	7	9	9.4	.39	.94
80	14.8	80	38.2	.....	.....	.....	8	8	11.2	.48	1.12
90	16.4	88	51.6	.....	.....	.....	9	8	13.4	.57	1.34
100	17.9	94	65.5	}	}	}	10	6	13.9	.65	1.39
110	19.3	98	79.4	} 57	} 31	} 12	11	4	13.9	.72	1.39
120	20.6	103	93.6	}	}	}	12	5	14.2	.78	1.42
130	21.8	107	108.0				13	4	14.4	.83	1.44
140	23.0	110	123.5	.....	.....	.....	14	3	15.5	.88	1.55
150	24.0	113	140.0	.....	.....	.....	15	3	16.5	.93	1.65
160	25.1	116	158.5	.....	.....	.....	16	3	18.5	.99	1.85
170	26.1	120	175.0	.....	.....	.....	17	4	16.5	1.03	1.65
180	27.0	123	192.5	.....	.....	.....	18	3	17.5	1.07	1.75
190	27.9	126	210.0	.....	.....	.....	19	3	17.5	1.10	1.75
200	28.8	129	226.5	.....	.....	.....	20	3	16.5	1.13	1.65
210	29.5	132	244.0	.....	.....	.....	21	3	17.5	1.16	1.75
220	30.3	135	261.5	.....	.....	.....	22	3	17.5	1.19	1.75
230	31.0	138	279.0	69	20	11	23	3	17.5	1.21	1.75

TABLE IV.—*Dimensions, volume, and rate of growth, by decades, etc.*—Continued.

(A) OLD-GROWTH PINE—Continued.

(7) CODOMINANT TREES.

[Average in Michigan.]

(28 trees.)

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodic accretion.			Average annual accretion.	Current annual accretion.
				Heartwood.	Sapwood.	Bark.	Decade.	Height.	Volume.		
Years.	*Inches.*	*Feet.*	*Cubic ft.*	*Per cent.*	*Per cent*	*Per cent.*		*Feet*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
10	0.7	7	(?)				1	7	(?)	(?)	(?)
20	2.2	16	0.4				2	9	(?)	0.02	(?)
30	4.0	29	1.3				3	13	0.9	.04	0.09
40	5.7	37	4.0				4	8	2.7	.10	.27
50	7.3	47	7.6				5	10	3.6	.15	.36
60	8.8	57	11.5				6	10	3.9	.19	.39
70	10.1	65	18.0				7	8	6.5	.26	.65
80	11.7	74	26.4				8	9	8.4	.33	.84
90	13.2	83	38.0				9	9	11.6	.42	1.16
100	14.6	89	50.0				10	6	12.0	.50	1.20
110	15.9	94	63.0				11	5	13.0	.57	1.30
120	17.2	99	77.0				12	5	14.0	.64	1.40
130	18.5	104	92.0				13	5	15.0	.71	1.50
140	19.8	108	106.0				14	4	14.0	.76	1.40
150	20.9	112	119.0				15	4	13.0	.79	1.30
160	22.1	116	130.0				16	4	11.0	.81	1.10
170	23.2	119	140.0				17	3	10.0	.82	1.00
180	24.1	123	(?)				18	4			
190	25.1	126	(?)				19	3			
200	26.0	129	(?)				20	3			
210	26.7	132	(?)				21	3			
220	27.4	135	(?)	63	24	13	22	3			
230	28.0	138	(?)				23	3			

(8) OPPRESSED TREES.

[Average in Michigan.]

(36 trees.)

10	0.7	4	(?)				1	4	(?)	(?)	(?)
20	1.8	12	0.3				2	8	(?)	0.015	(?)
30	3.3	20	.7				3	8	0.4	.02	0.04
40	5.0	28	1.8				4	8	1.1	.04	.11
50	6.6	37	4.0				5	9	2.2	.08	.22
60	8.0	47	7.0				6	10	3.0	.12	.30
70	9.2	56	11.0				7	9	4.0	.16	.40
80	10.5	64	16.6				8	8	5.6	.21	.56
90	11.8	71	23.0				9	7	6.4	.25	.64
100	13.2	77	30.0				10	6	7.0	.30	.70
110	14.6	83	37.0	51	36	13	11	6	7.0	.34	.70
120	15.8	88	45.0				12	5	8.0	.37	.80
130	17.0	92	54.0				13	4	9.0	.41	.90
140	18.0	97	64.0				14	5	10.0	.46	1.00
150	19.0	100	74.0				15	3	10.0	.50	1.00
160	20.0	103	84.0				16	3	10.0	.52	1.00
170	20.8	106	95.0				17	3	11.0	.56	1.10
180	21.6	109	106.0				18	3	11.0	.60	1.10
190	22.4	111	116.0				19	2	10.0	.61	1.00
200	23.2	113	126.0				20	2	10.0	.63	1.00
210	23.8	115	137.0				21	2	11.0	.65	1.10
220	24.4	117	147.0				22	2	10.0	.67	1.00
230	24.9	119	157.0	68	19	13	23	2	10.0	.68	1.00

(9) DOMINANT TREES.

[Average in Pennsylvania.]

(81 trees.)

10	1.0	7	(?)				1	7	(?)	(?)	(?)
20	2.8	21	0.5				2	14	(?)	0.02	(?)
30	5.5	35	2.6				3	14	2.1	.09	0.21
40	8.0	49	7.8				4	14	5.2	.20	.52
50	10.2	60	14.4	40	47	13	5	11	6.6	.29	.66
60	12.2	70	24.9				6	10	10.5	.41	1.05
70	14.0	78	36.1				7	8	11.2	.52	1.12
80	15.6	86	48.3				8	8	12.2	.60	1.22
90	17.1	93	59.6				9	7	11.3	.66	1.13
100	18.6	99	74.6				10	6	15.0	.75	1.50
110	20.0	104	90.7	53	35	12	11	5	16.1	.82	1.61
120	21.5	108	106.9				12	4	16.2	.89	1.62
130	22.9	112	123.6				13	4	16.7	.95	1.67
140	24.1	116	140.9				14	4	17.3	1.00	1.73
150	25.2	119	158.2				15	3	17.3	1.06	1.73
160	26.4	122	176.9				16	3	18.7	1.10	1.87
170	27.5	125	196.2				17	3	19.3	1.15	1.93
180	28.6	128	217.4				18	3	21.2	1.21	2.12
190	29.6	131	238.0				19	3	20.6	1.25	2.06
200	30.8	134	260.5				20	3	22.5	1.30	2.25
210	31.9	137	284.2				21	3	23.7	1.35	2.37
220	33.0	140	309.7				22	3	25.5	1.41	2.55
230	34.0	143	335.4	69	21	10	23	3	25.7	1.46	2.57

TABLE IV.—*Dimensions, volume, and rate of growth, by decades, etc.*—Continued.

(A) OLD-GROWTH PINE—Continued

(10) CODOMINANT TREES.

[Average in Pennsylvania.]

(78 trees.)

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodic accretion.			Average annual accretion.	Current annual accretion.
				Heartwood.	Sapwood.	Bark.	Decade.	Height.	Volume.		
Years.	*Inches.*	*Feet.*	*Cubic ft.*	*Per cent.*	*Per cent.*	*Per cent.*		*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
10	0.9	5	(1)	.....	.....	.....	1	5	(1)	(1)	(1)
20	2.3	16	0.4	.....	.....	.....	2	11	(1)	0.02	(1)
30	4.0	28	1.8	.....	.....	.....	3	12	1.4	.06	0.14
40	5.9	39	4.8	.....	.....	.....	4	11	3.0	.12	.30
50	7.6	48	7.8	.....	.....	.....	5	9	3.0	.15	.30
60	9.4	56	11.1	.....	.....	.....	6	8	3.3	.18	.33
70	10.8	63	16.7	.....	.....	.....	7	7	5.6	.24	.56
80	12.0	69	23.3	.....	.....	.....	8	6	6.6	.29	.66
90	13.4	75	30.7	.....	.....	.....	9	6	7.4	.34	.74
100	14.7	80	39.0	.....	.....	.....	10	5	8.3	.39	.83
110	16.0	85	47.9	.....	.....	.....	11	5	8.9	.43	.89
120	17.3	90	57.9	.....	.....	.....	12	5	10.0	.48	1.00
130	18.6	94	65.2	.....	.....	.....	13	4	7.3	.50	.73
140	19.7	98	76.9	.....	.....	.....	14	4	11.7	.55	1.17
150	20.7	102	88.9	.....	.....	.....	15	4	12.0	.59	1.20
160	21.8	106	101.8	.....	.....	.....	16	4	12.9	.63	1.29
170	22.7	109	115.3	.....	.....	.....	17	3	13.5	.68	1.35
180	23.5	112	129.2	.....	.....	.....	18	3	13.9	.72	1.39
190	24.3	114	142.9	.....	.....	.....	19	2	13.7	.75	1.37
200	25.1	116	152.7	.....	.....	.....	20	2	9.8	.76	.98
210	25.8	118	165.5	.....	.....	.....	21	2	12.8	.79	1.28
220	26.5	120	179.3	.....	.....	.....	22	2	13.8	.81	1.38
230	27.3	122	195.0	65	25	10	23	2	15.7	.84	1.57

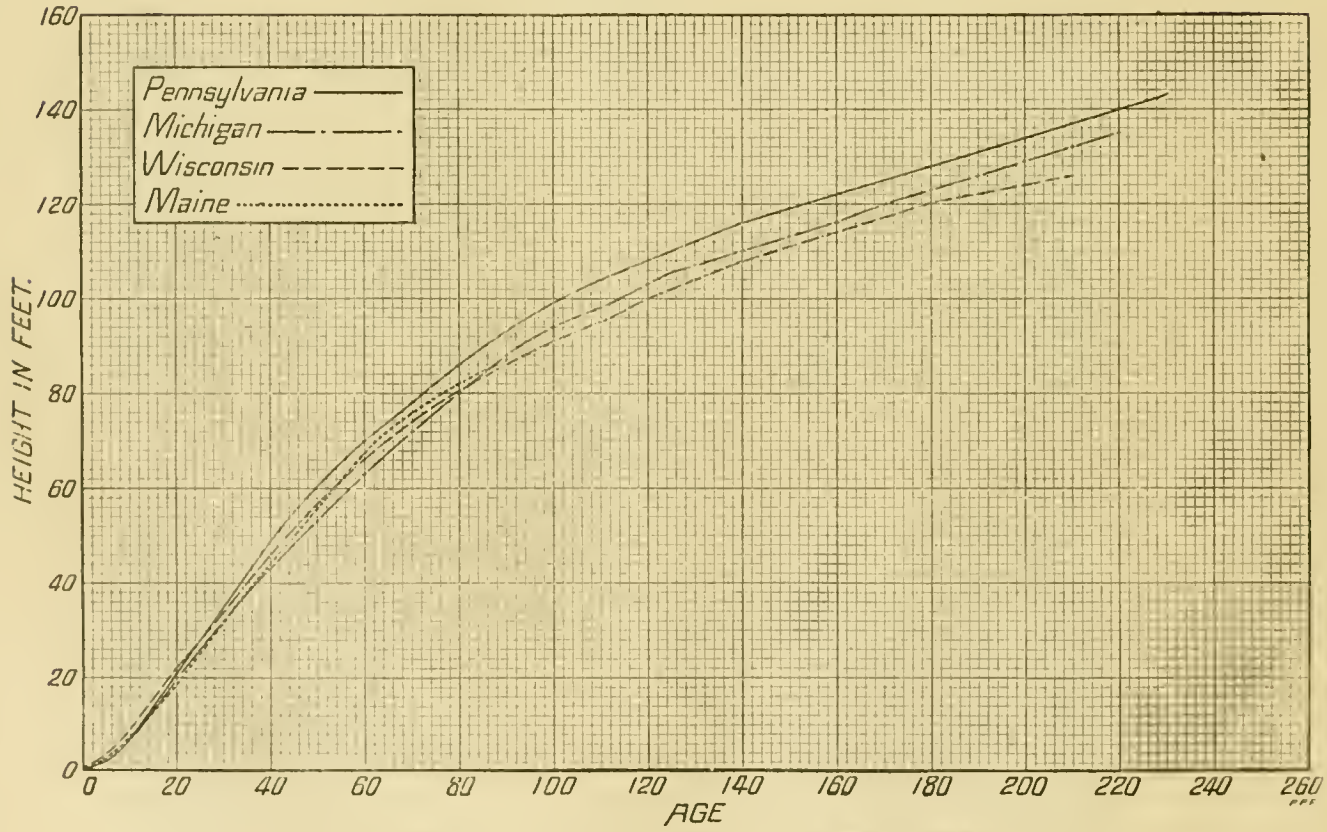


FIG. 24.—Diagram showing height growth of dominant trees, by States.

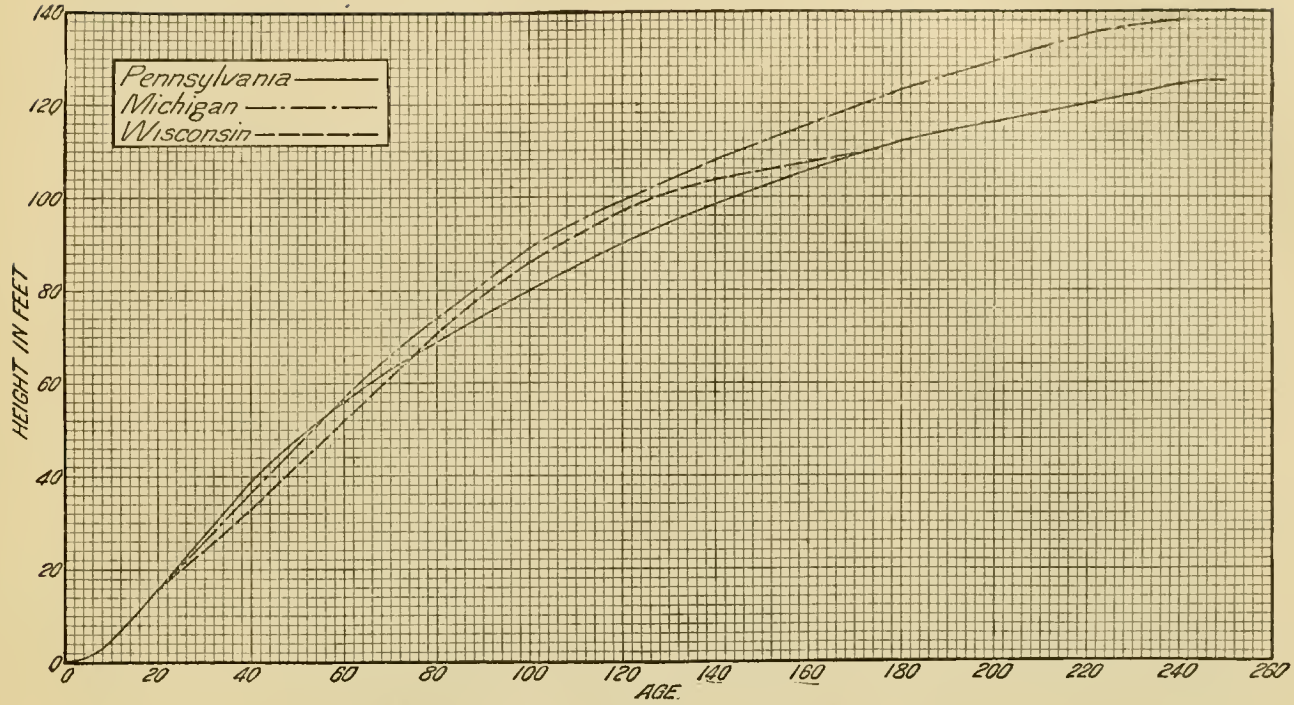


FIG. 25.—Diagram showing height growth of codominant trees, by States.

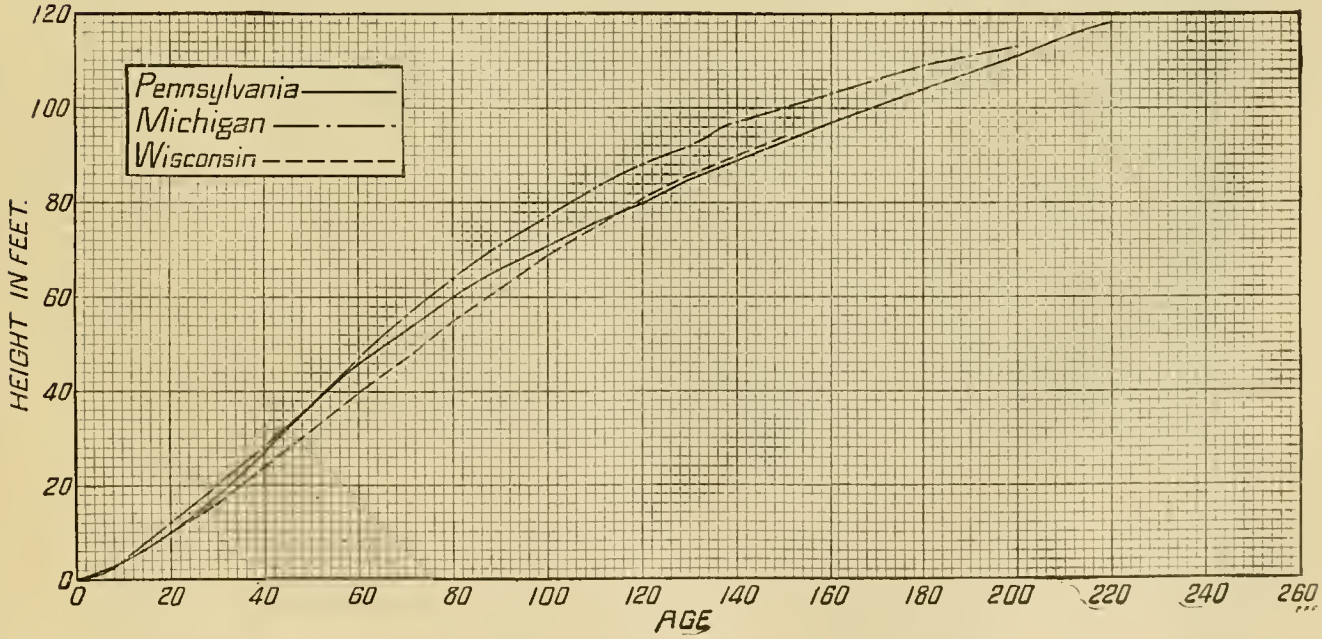


FIG. 26.—Diagram showing height growth of oppressed trees, by States.

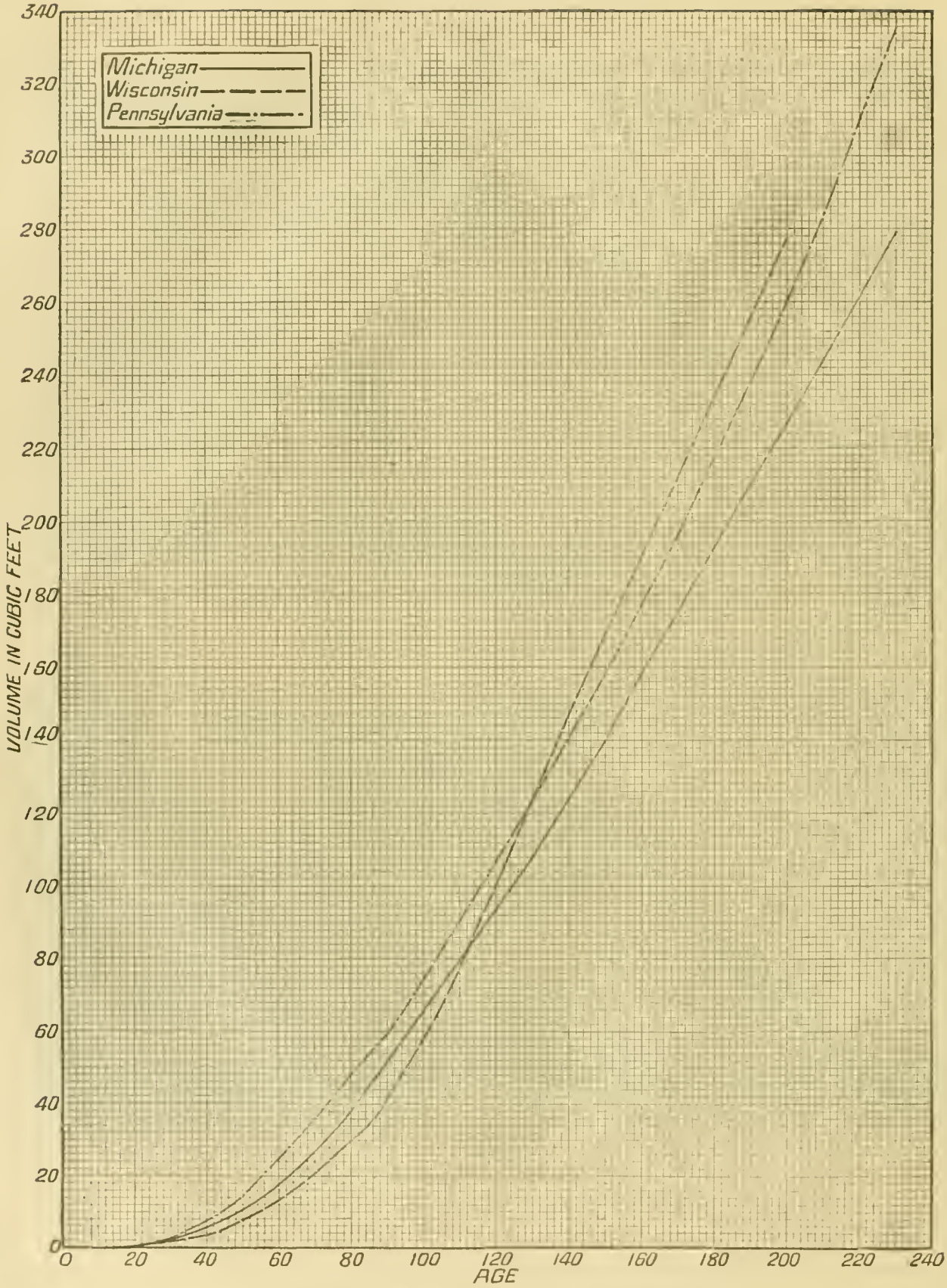


FIG. 27.—Diagram showing volume growth of dominant trees, by States.

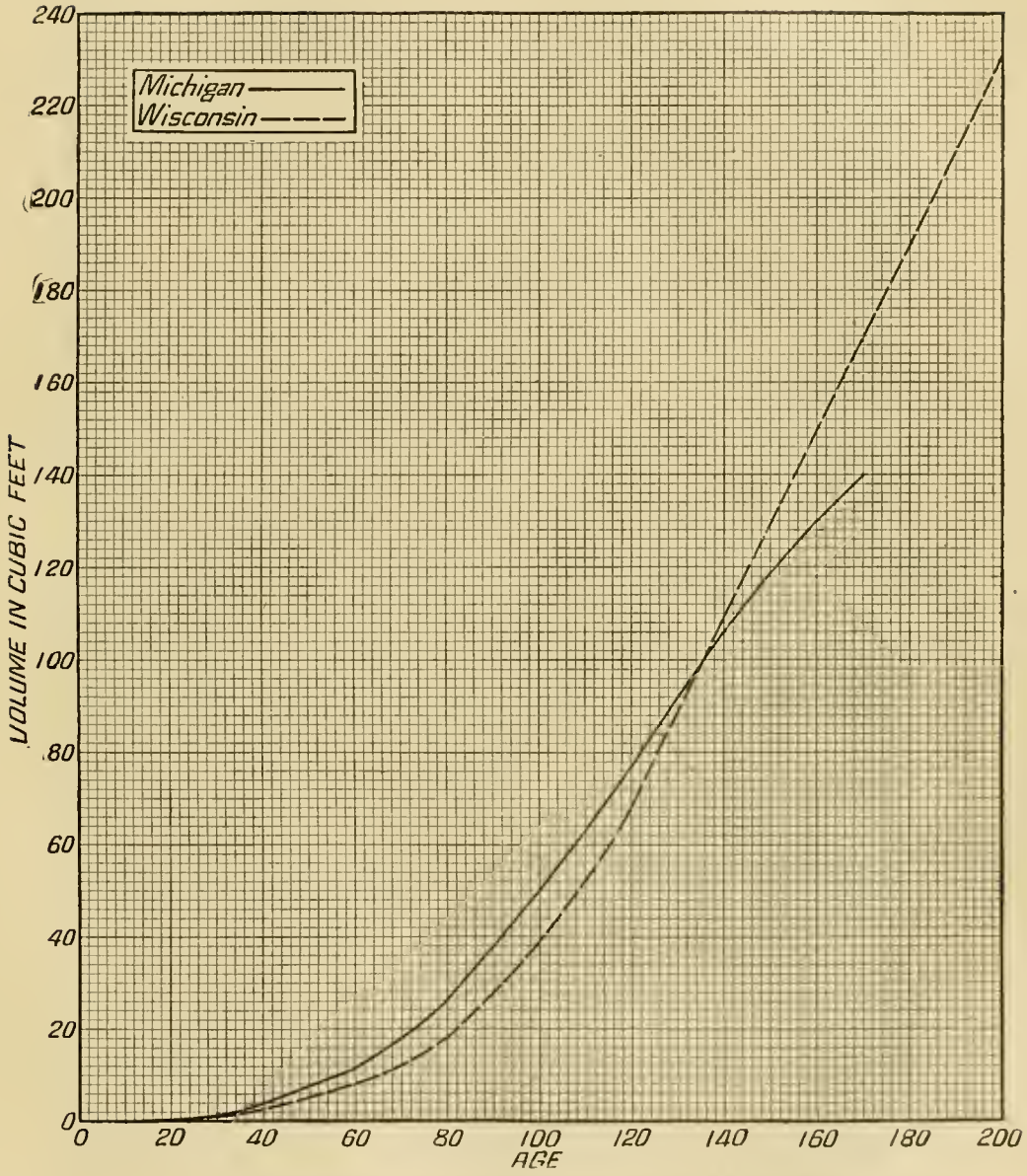


FIG. 28.—Diagram showing volume growth of codominant trees, by States.

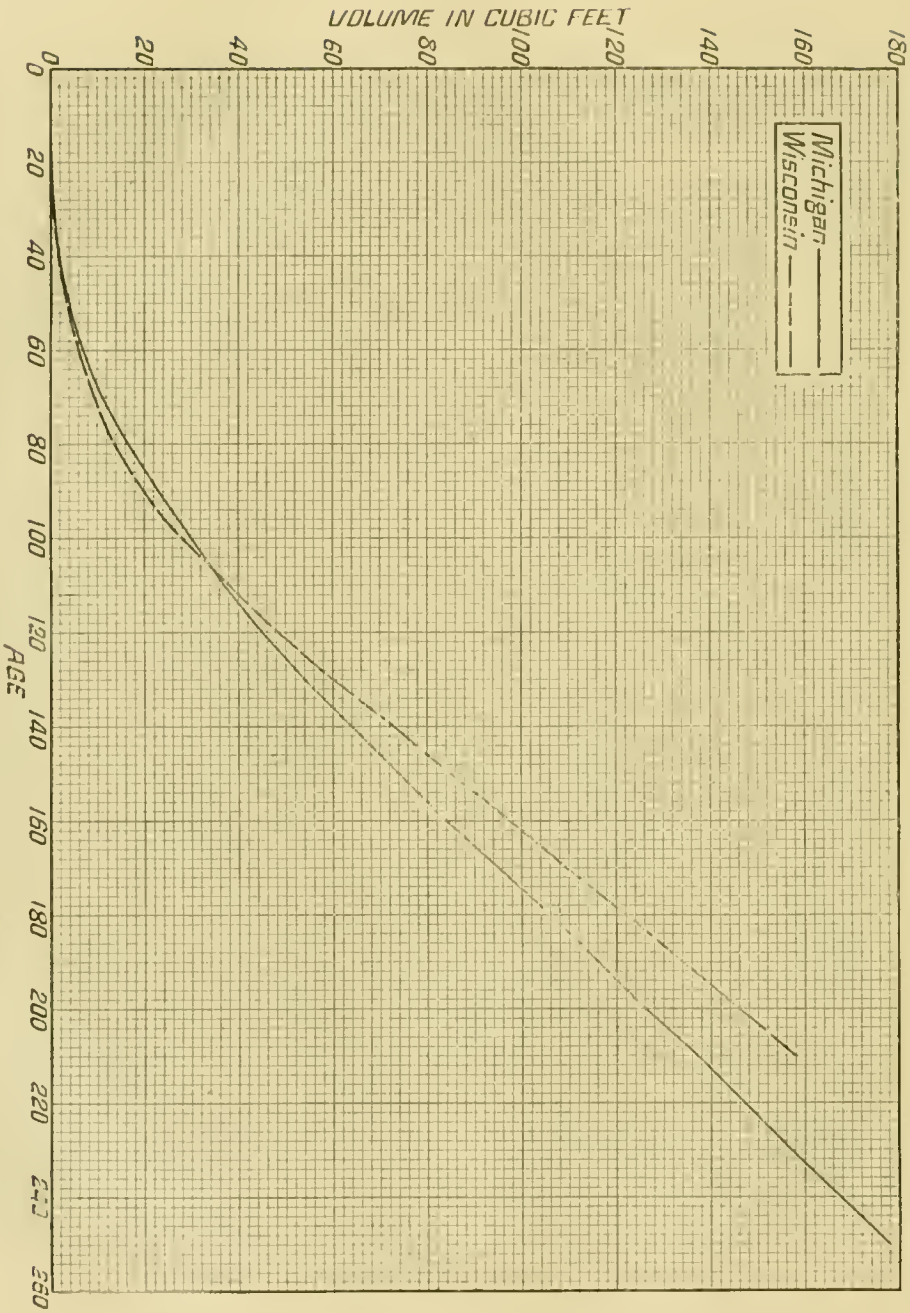


Fig. 29.—Diagram showing volume growth of oppressed trees, by States.

TABLE IV.—*Dimensions, volume, and rate of growth, by decades, etc.*—Continued.

(*B*) SECOND-GROWTH PINE.

(11) SITE *a*: YORK COUNTY, ME.

DOMINANT TREES.

(11 trees.)

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodic accretion.			Average annual accretion.	Current annual accretion
				Heart wood.	Sapwood.	Bark.	Decade.	Height.	Volume.		
Years.	*Inches*	*Feet.*	*Cubic ft.*	*Per cent.*	*Per cent.*	*Per cent.*		*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft*
10	2.1	7½	0.5	.....	.....	.....	1	7½	0.2	0.05	0.05
20	5.7	21	2.1	.....	.....	.....	2	13½	1.6	.10	.16
30	10.2	37	6.5	.....	.....	.....	3	16	4.4	.21	.44
40	14.2	49½	17.0	.....	.....	.....	4	12½	10.5	.42	1.05
50	18.6	60½	34.0	.....	.....	.....	5	11	17.0	.68	1.70
60	22.1	69	60.3	.....	.....	.....	6	8½	26.3	1.00	2.63
70	24.6	77	82.2	} 58	29	10	7	8	21.9	1.17	2.19
80	26.2	85	100.0	to	to	to	8	8	17.8	1.25	1.78
90	.....	90	(*b*)	} 60	32	11	9	5	.....	.....	.....

CODOMINANT TREES.

(33 trees.)

10	1.8	7	0.2	.....	.....	.....	1	7	0.2	0.02	0.02
20	4.1	17½	.7	.....	.....	.....	2	10½	.5	.03	.05
30	6.2	30	2.4	.....	.....	.....	3	12½	1.7	.08	.17
40	8.6	43	6.4	.....	.....	.....	4	13	4.0	.16	.40
50	11.7	56	14.6	.....	.....	.....	5	13	8.2	.29	.82
60	14.8	66½	26.2	.....	.....	.....	6	10½	11.6	.44	1.16
70	17.3	75	39.6	} 47	34	11	7	8½	13.4	.56	1.34
80	19.1	81½	54.0	to	to	to	8	6½	14.4	.67	1.44
90	21.0	87	70.0	} 55	41	12	9	5½	16.0	.78	1.60

OPPRESSED TREES.

(12 trees.)

10	1.5	6	(*b*)	.....	.....	.....	1	6	(*b*)	(*b*)	(*b*)
20	4.5	18	0.7	.....	.....	.....	2	12	(*b*)	0.03	(*b*)
30	7.2	30	2.8	.....	.....	.....	3	12	2.1	.09	0.21
40	9.5	41½	6.6	.....	.....	.....	4	11½	3.8	.16	.38
50	11.2	53	12.3	.....	.....	.....	5	11½	5.7	.25	.57
60	12.8	66½	19.0	.....	.....	.....	6	13½	6.7	.31	.67
70	14.0	75½	26.0	.....	.....	.....	7	9	7.0	.36	.70
80	15.0	79½	32.4	.....	.....	.....	8	4	6.4	.40	.64
90	15.4	83½	39.0	68	28	12	9	4	6.6	.43	.66

(12) SITE *c*: YORK COUNTY, ME.

DOMINANT TREES.

(10 trees.)

10	1.9	7.5	0.5	.....	.....	.....	1	7.5	0.5	0.05	0.05
20	6.1	19.0	1.2	.....	.....	.....	2	11.5	.7	.06	.07
30	9.4	32.0	5.0	.....	.....	.....	3	13.0	3.8	.17	.38
40	12.1	45.0	12.0	.....	.....	.....	4	13.0	7.0	.30	.70
50	13.9	58.0	21.4	43	45	12	5	13.0	9.4	.43	.94

DOMINANT TREES.

(8 trees.)

10	2.2	9.7	0.2	.....	.....	.....	1	9.7	0.2	0.02	0.02
20	5.6	21.3	1.0	.....	.....	.....	2	11.6	.8	.05	.08
30	7.7	33.4	3.8	.....	.....	.....	3	12.1	2.8	.13	.28
40	9.0	43.0	8.4	.....	.....	.....	4	9.6	4.6	.21	.46
50	10.3	56.0	13.0	43	45	12	5	13.0	4.6	.26	.46

(13) MASSACHUSETTS AND NEW HAMPSHIRE.

DOMINANT TREES.

(12 trees.)

10	2.2	9	0.1	.....	.....	.....	1	9	0.1	0.01	0.01
20	4.7	25	1.4	.....	.....	.....	2	16	1.3	.07	.13
30	7.5	39	4.3	.....	.....	.....	3	14	2.9	.14	.29
40	9.6	53	9.3	40	51	9	4	14	5.0	.23	.50

(Average in Massachusetts and New Hampshire of 12 trees.)

10	2.5	10	0.5	.....	.....	.....	1	10	0.5	0.05	0.05
20	5.4	33	2.0	.....	.....	.....	2	23	1.5	.10	.15
30	7.8	48	6.5	.....	.....	.....	3	15	4.5	.22	.45
40	9.4	58	12.5	48	46	6	4	10	6.0	.31	.60

TABLE IV.—*Dimensions, volume, and rate of growth, by decades, etc.*—Continued.

(*B*) SECOND-GROWTH PINE—Continued.

(14) SITE *g*. CLEARFIELD COUNTY, PA.

DOMINANT TREES.

(4 trees.)

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodic accretion.			Average annual accretion	Current annual accretion.
				Heartwood.	Sapwood.	Bark.	Decade.	Height.	Volume.		
Years	*Inches.*	*Feet.*	*Cubic ft.*	*Per cent.*	*Per cent.*	*Per cent.*		*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
10	2.6	9	0.1	.....	.....	.....	1	9	0.1	0.01	0.01
20	7.3	27	3.0	.....	.....	.....	2	18	2.9	.15	.29
30	13.2	41½	13.5	37	55	8	3	14½	10.5	.45	1.05

CODOMINANT TREES.

(5 trees.)

10	1.8	9	0.1	.....	.....	.....	1	9	0.1	0.01	0.01
20	6.4	27	1.9	.....	.....	.....	2	18	1.8	.09	.18
30	10.8	41	8.0	34	52	14	3	14	6.1	.20	.61

OPPRESSED TREES.

(3 trees.)

10	1.6	7	0.04	.....	.....	.....	1	7	0.04	0.004	0.004
20	4.1	25	.60	.....	.....	.....	2	18	.56	.03	.056
30	6.3	35	2.90	27	60	13	3	10	2.30	.10	.230

SUPPRESSED TREES.

(3 trees.)

10	1.1	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	2.4	21	.....	.....	.....	.....	.....	.....	.....	.....	.....

(15) SITE *i*: FOREST COUNTY, PA.

DOMINANT TREES.

(2 trees.)

10	1.8	9	(?)	.....	.....	.....	1	9	(?)	(?)	(?)
20	6.9	29½	2.5	.....	.....	.....	2	20½	(?)	0.12	(?)
30	10.4	41½	9.7	.....	.....	.....	3	12	7.2	.32	0.72
40	12.9	52½	19.0	36	54	10	4	11	9.3	.47	.93

DOMINANT TREES.

(10 trees.)

10	2.1	9	(?)	.....	.....	.....	1	9	(?)	(?)	(?)
20	5.9	27	1.8	.....	.....	.....	2	18	(?)	0.09	(?)
30	8.7	41½	6.0	.....	.....	.....	3	14½	4.2	.20	0.42
40	11.0	53	13.0	35	52	13	4	11½	7.0	.32	.70

CODOMINANT TREES.

(10 trees.)

10	1.9	9	(?)	.....	.....	.....	1	9	(?)	(?)	(?)
20	4.8	27	1.3	.....	.....	.....	2	18	(?)	0.06	(?)
30	6.8	40	4.7	.....	.....	.....	3	13	3.4	.16	0.34
40	8.5	52	9.8	36	53	11	4	12	5.1	.24	.51

OPPRESSED TREES.

(5 trees.)

10	2.1	7	(?)	.....	.....	.....	1	7	(?)	(?)	.....
20	4.2	23	1.0	.....	.....	.....	2	16	(?)	0.05	.....
30	5.7	36	2.7	.....	.....	.....	3	13	1.7	.09	0.17
40	6.6	44	4.8	34	55	11	4	8	2.1	.12	.21

(16) SITE *c*: LUZERNE COUNTY, PA.

DOMINANT TREES.

(9 trees.)

10	1.0	6	(?)	.....	.....	.....	1	6	(?)	(?)	(?)
20	3.2	19	0.4	.....	.....	.....	2	13	(?)	0.02	(?)
30	5.9	33	2.5	.....	.....	.....	3	14	2.1	.08	0.21
40	8.7	44½	7.2	.....	.....	.....	4	11½	4.7	.18	.47
50	11.5	51	14.0	40	47	13	5	6½	6.8	.28	.68

TABLE V.—*Growth of diameter and cross-section area at various heights from the ground.*

(1) AVERAGE THROUGHOUT THE RANGE.

DIAMETER OF SECTION, IN INCHES, AT AGE (YEARS) OF—

Character of growth.	Height of section from ground.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230
	Feet.																							
Dominant (224 trees).	2½	1.9	4.1	6.2	8.2	9.9	11.6	13.2	14.8	16.6	18.4	20.1	21.7	23.2	24.7	26.0	27.2	28.4	29.6	30.7	31.7	32.6	33.6	34.5
	18	2.8	5.4	7.3	9.0	10.5	11.9	13.3	14.6	15.8	17.0	18.2	19.3	20.3	21.2	22.1	22.9	23.7	24.5	25.2	25.9	26.4	26.9	
	34	2.7	5.3	7.5	9.3	10.9	12.4	13.8	15.1	16.3	17.4	18.5	19.4	20.3	21.1	21.9	22.6	23.3	24.0	24.8	25.4	26.0		
	50	2.6	5.4	7.7	9.6	11.2	12.7	14.0	15.1	16.2	17.1	18.0	18.9	19.7	20.5	21.3	22.0	22.7	23.4	24.0	24.7			
	66	2.5	5.1	7.2	9.3	10.9	12.2	13.4	14.5	15.5	16.5	17.4	18.2	18.9	19.6	20.3	20.9	21.5	22.0					
	82	2.3	4.4	6.1	7.6	9.0	10.2	11.3	12.3	13.3	14.1	14.9	15.7	16.5	17.2	17.9	18.6							
	100	1.9	3.8	5.4	6.9	8.2	9.4	10.4	11.4	12.3	13.2	14.1	14.9	15.8	16.6									
	115	1.4	2.9	4.4	5.6	6.9	8.1	9.3	10.4	11.3	12.1													
Codominant (106 trees).	2½	1.6	3.5	5.3	7.0	8.6	10.0	11.4	12.9	14.3	15.6	16.9	18.3	19.5	20.6	21.7	22.8	23.8	24.7	25.6	26.4	27.1	27.8	28.5
	18	2.4	4.9	6.7	8.3	9.6	10.8	12.0	13.1	14.1	15.1	16.0	17.0	17.8	18.5	19.2	19.9	20.6	21.2	21.8	22.4	23.0	23.6	
	34	2.6	5.1	7.0	8.6	10.0	11.2	12.3	13.3	14.2	15.1	15.9	16.7	17.4	18.1	18.7	19.4	20.0	20.6	21.1	21.8	22.4		
	50	2.6	4.9	6.9	8.6	10.1	11.4	12.4	13.4	14.3	15.2	16.0	16.8	17.5	18.2	18.9	19.5	20.2	20.8	21.4				
	66	2.2	4.3	6.1	7.6	8.9	10.0	11.0	11.9	12.7	13.5	14.3	15.0	15.7	16.3	17.0	17.6	18.2						
	82	1.9	3.8	5.3	6.7	7.9	9.0	10.0	10.9	11.7	12.4	13.1	13.7	14.3	15.0									
	98	1.6	2.9	4.2	5.4	6.5	7.6	8.5	9.6	10.2	10.8	11.5												
	114	1.0	2.0	3.1	4.2	5.2																		
Oppressed (104 trees).	2½	1.4	3.1	4.8	6.4	7.7	8.9	10.3	11.5	13.0	14.3	15.7	16.9	18.1	19.2	20.3	21.3	22.3	23.2	24.0	24.8	25.4	25.9	26.4
	18	2.1	4.2	5.8	7.1	8.1	9.2	10.1	11.2	12.4	13.4	14.4	15.3	16.1	16.9	17.7	18.4	19.0	19.5	19.9	20.3			
	34	2.2	4.4	6.2	7.9	9.3	10.5	11.6	12.7	13.6	14.4	15.2	16.0	16.7	17.4	18.0	18.4	18.8	19.1					
	50	2.1	4.3	6.2	7.7	9.1	10.4	11.6	12.6	13.6	14.5	15.4	16.2	16.8	17.4	17.8	18.2	18.7						
	66	2.4	4.7	6.4	7.9	9.1	10.3	11.3	12.2	12.9	13.5	14.0	14.5	15.0	15.5	15.9								
	82	2.3	4.1	5.7	6.9	7.8	8.4	9.1	9.8	10.2	10.6	11.0	11.4	11.9										
	100	1.9	3.8	5.0	5.9	6.7	7.4	8.1	8.6	9.0														

DIAMETER ACCRETION, IN INCHES, FOR DECADES—

Character of growth.	Height of section from ground.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Feet.																							
Dominant (224 trees).	2½	1.9	2.2	2.1	2.0	1.7	1.7	1.6	1.6	1.8	1.8	1.7	1.6	1.6	1.5	1.3	1.2	1.2	1.2	1.1	1.0	0.9	1.0	0.9
	18	2.8	2.6	1.9	1.7	1.5	1.4	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.5	0.5	
	34	2.7	2.6	2.2	1.8	1.6	1.5	1.4	1.3	1.2	1.1	1.1	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.8	0.6	0.6		
	50	2.6	2.8	2.3	1.9	1.6	1.5	1.3	1.1	1.1	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.6	0.7			
	66	2.5	2.6	2.1	2.1	1.6	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.7	0.7	0.7	0.6	0.6	0.5					
	82	2.3	2.1	1.7	1.5	1.4	1.2	1.1	1.0	1.0	0.8	0.8	0.8	0.8	0.7	0.7	0.7							
	100	1.9	1.9	1.6	1.5	1.3	1.2	1.0	1.0	0.9	0.9	0.9	0.8	0.9	0.8									
	115	1.4	1.5	1.5	1.2	1.3	1.2	1.2	1.1	0.9	0.8													
Codominant (106 trees).	2½	1.6	1.9	1.8	1.7	1.6	1.4	1.4	1.5	1.4	1.3	1.3	1.4	1.2	1.1	1.1	1.1	1.0	0.9	0.9	0.8	0.7	0.7	0.7
	18	2.4	2.5	1.8	1.6	1.3	1.2	1.2	1.1	1.0	1.0	0.9	1.0	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
	34	2.6	2.5	1.9	1.6	1.4	1.2	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.5	0.7	0.6		
	50	2.6	2.3	2.0	1.7	1.5	1.3	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.7	0.6	0.6				
	66	2.2	2.1	1.8	1.5	1.3	1.1	1.0	0.9	0.8	0.8	0.8	0.7	0.7	0.6	0.7	0.6	0.6						
	82	1.9	1.9	1.5	1.4	1.2	1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.6	0.7									
	98	1.6	1.3	1.3	1.2	1.1	1.1	0.9	1.1	0.6	0.6	0.7												
	114	1.0	1.0	1.1	1.1	1.0																		
Oppressed (104 trees).	2½	1.4	1.7	1.7	1.6	1.3	1.2	1.4	1.2	1.5	1.3	1.4	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.8	0.8	0.6	0.5	0.5
	18	2.1	2.1	1.6	1.3	1.0	1.1	0.9	1.1	1.2	1.0	1.0	0.9	0.8	0.8	0.8	0.7	0.6	0.5	0.4	0.4			
	34	2.2	2.2	1.8	1.7	1.4	1.2	1.1	1.1	0.9	0.8	0.8	0.8	0.7	0.7	0.6	0.4	0.4	0.3					
	50	2.1	2.2	1.9	1.5	1.4	1.3	1.2	1.0	1.0	0.9	0.9	0.8	0.6	0.6	0.4	0.4	0.5						
	66	2.4	2.3	1.7	1.5	1.2	1.2	1.0	0.9	0.7	0.6	0.5	0.5	0.5	0.5	0.4								
	82	2.3	1.8	1.6	1.2	0.9	0.6	0.7	0.7	0.4	0.4	0.4	0.4	0.5										
	100	1.9	1.9	1.2	0.9	0.8	0.7	0.7	0.5	0.4														

CORRESPONDING AREA ACCRETION, IN SQUARE FEET, FOR DECADES—

Character of growth.	Height of section from ground.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Feet.																							
Dominant (224 trees).	2½	0.02	0.07	0.13	0.16	0.18	0.20	0.21	0.24	0.30	0.33	0.35	0.35	0.36	0.39	0.35	0.36	0.38	0.38	0.37	0.34	0.32	0.35	0.32
	18	.04	.12	.13	.16	.17	.17	.19	.20	.20	.22	.23	.22	.22	.20	.21	.21	.20	.22	.20	.20	.14	.15	
	34	.04	.12	.15	.17	.18	.18	.20	.20	.20	.20	.21	.18	.19	.19	.19	.18	.18	.18	.20	.16	.16		
	50	.04	.13	.16	.18	.18	.19	.19	.18	.19	.18	.17	.17	.18	.17	.17	.18	.15	.16	.15	.16			
	66	.03	.11	.14	.15	.17	.16	.17	.12	.17	.16	.17	.15	.14	.14	.15	.15	.14	.12					
	82	.03	.07	.10	.11	.12	.13	.12	.12	.14	.13	.12	.12	.14	.13	.13	.14							
	100	.02	.06	.08	.11	.10	.12	.11	.12	.12	.13	.12	.12	.16	.14									
	115	.01	.03	.07	.07	.09	.10	.11	.10	.11														
Codominant (106 trees).	2½	.01	.06	.09	.11	.13	.15	.16	.19	.21	.21	.23	.27	.24	.23	.24	.27	.24	.23	.23	.22	.20	.21	.21
	18	.03	.10	.12	.13	.12	.14	.14	.15	.15	.15	.15	.17	.15	.14	.14	.15	.14	.14	.13	.14	.14	.15	
	34	.04	.10	.13	.13	.14	.14	.14	.11	.14	.14	.14	.13	.13	.13	.12	.14	.13	.13	.12	.15	.13		
	50	.04	.09	.14	.14	.15	.15	.13	.11	.14	.14	.13	.14	.13	.13	.13	.12	.14	.12	.13				
	66	.03	.07	.10	.11	.12	.11	.12	.11	.10	.11	.12	.11	.12	.10	.11	.10	.12						
	82	.02	.06	.08	.09	.09	.10	.10	.10	.10	.09	.10	.09	.08	.10									
	98	.02	.03	.06	.06	.07	.08	.08	.10	.07	.07	.09												
	114	.01	.01	.03	.05	.05																		
Oppressed (104 trees).	2½	.01	.04	.07	.10	.10	.11	.15	.14	.19	.20	.22	.20	.22	.22	.23	.23	.21	.22	.20	.20	.15	.14	.13
	18	.02	.08	.08	.09	.08	.10	.09	.13	.15	.14	.15	.14	.14	.13	.14	.12	.11	.10	.08	.08			
	34	.03	.08	.11	.13	.13	.13	.13	.14	.13	.12	.12	.13	.13	.12	.12	.12	.08	.08					
	50	.02	.08	.11	.11	.12	.14	.14	.14	.13	.13	.13	.13	.10	.11	.07	.07	.10						
	66	.03	.09	.11	.12	.11	.12	.12	.11	.10	.09	.07	.08	.07	.08	.07								
	82	.03	.06	.09	.08	.07	.05	.07	.07	.05	.04	.05	.05	.06										
	100	.02	.06	.06	.05	.05	.06	.06	.01	.04														

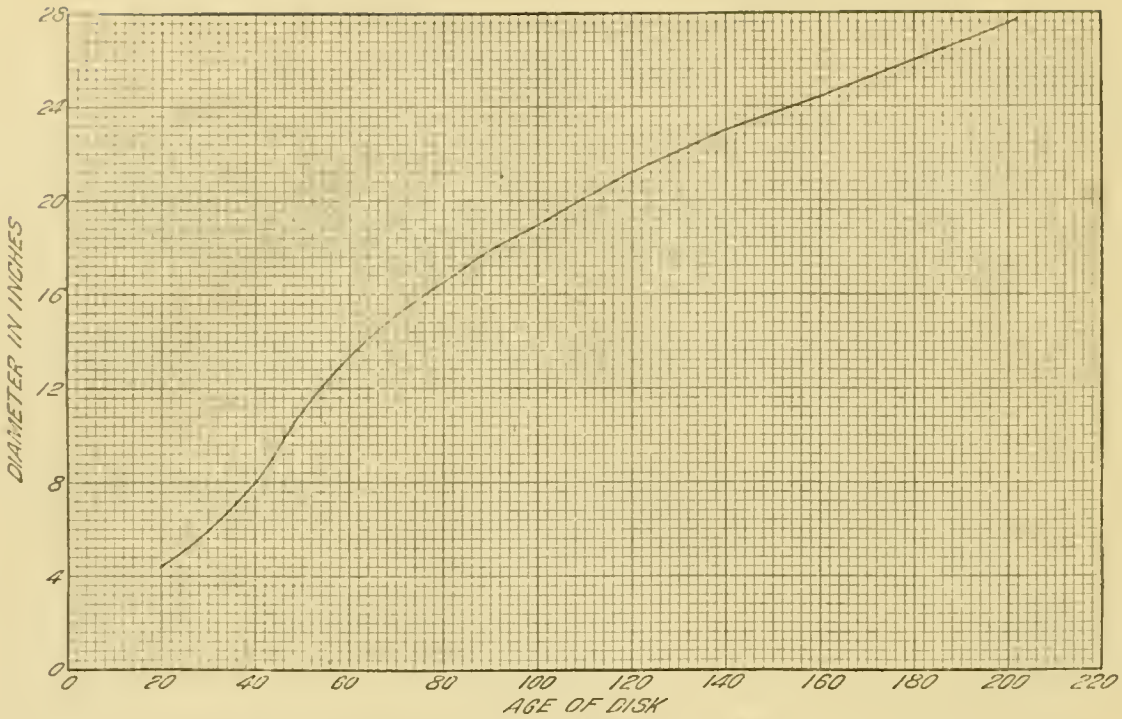


FIG. 30.—Diagram showing average progress of diameter growth (breast high) of dominant trees.

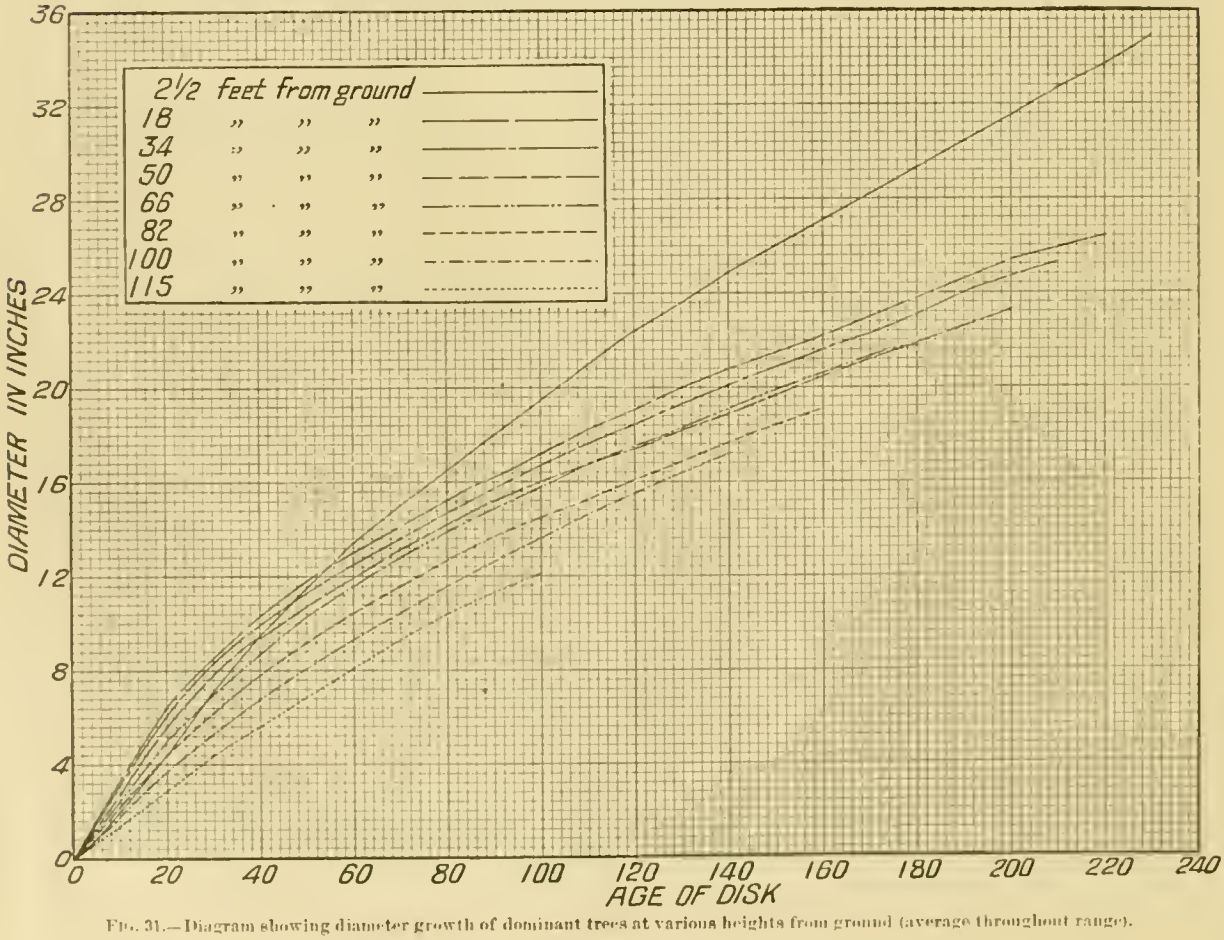


FIG. 31.—Diagram showing diameter growth of dominant trees at various heights from ground (average throughout range).

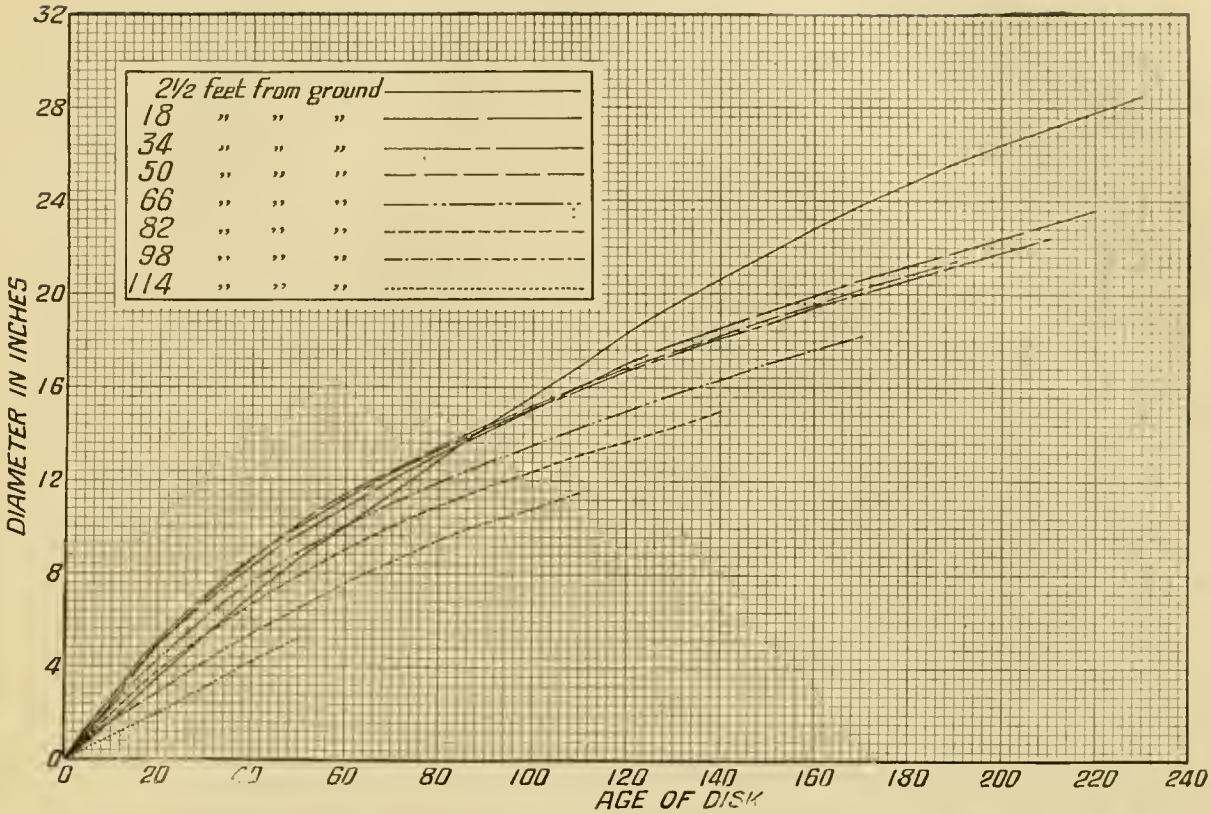


FIG. 32.—Diagram showing diameter growth of codominant trees at various heights from ground (average throughout range).

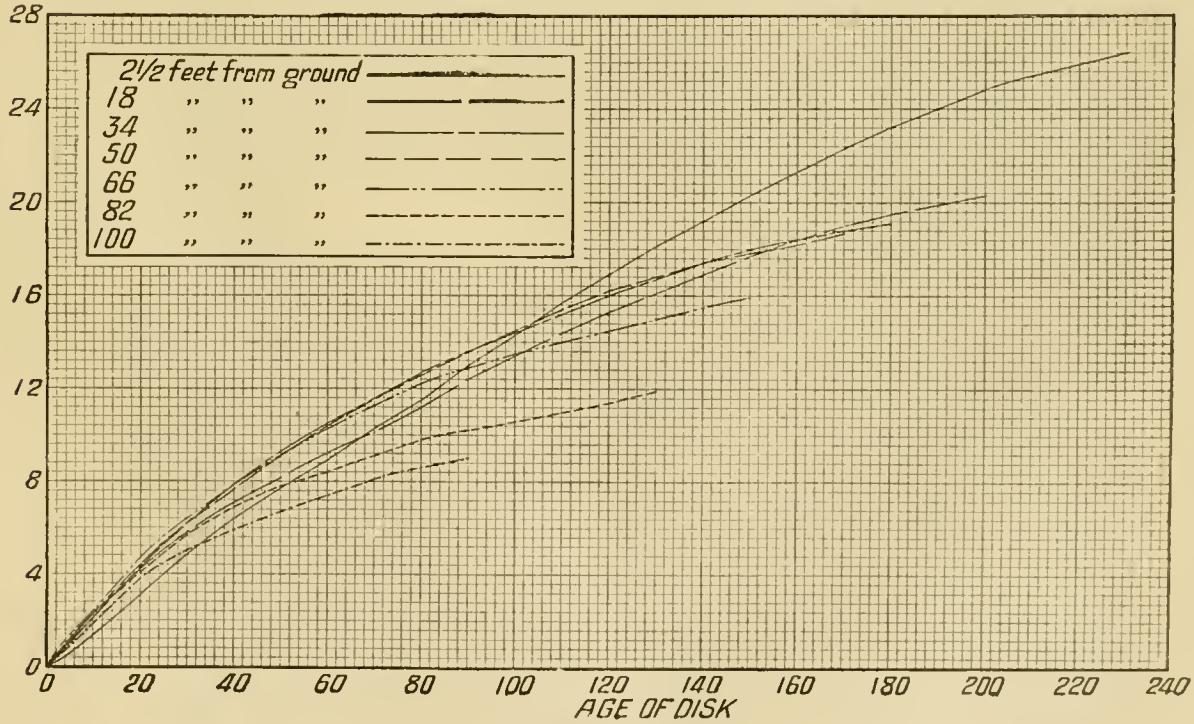


FIG. 33.—Diagram showing diameter growth of oppressed trees at various heights from ground (average throughout range).

TABLE V.—*Growth of diameter and cross-section area at various heights from the ground*—Continued.

(2) AVERAGE FOR WISCONSIN.

DIAMETER OF SECTION, IN INCHES, AT AGE (YEARS) OF—

Character of growth.	Height of section from ground.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230
	Feet.																							
Dominant (68 trees).	½	1.6	3.3	4.8	6.2	7.5	8.8	10.3	12.0	14.2	16.6	18.9	21.0	23.1	25.1	26.8	28.4	30.0	31.5	32.8	34.0			
	18	2.1	4.2	5.8	7.2	8.6	10.1	11.7	13.3	14.8	16.4	17.9	19.3	20.4	21.5	22.6	23.6	24.5	25.4	26.2				
	34	2.2	4.4	6.4	8.3	10.1	11.9	13.5	15.1	16.6	17.9	19.0	20.0	21.0	21.9	22.8	23.6	24.4						
	50	2.4	5.0	7.4	9.5	11.3	13.0	14.5	15.8	17.1	18.2	19.2	20.2	21.0	21.8	22.6	23.4							
	66	2.4	5.0	7.2	9.2	11.0	12.5	13.9	15.1	16.2	17.2	18.1	18.8	19.4	20.0									
	82	2.3	4.1	6.1	7.6	9.0	10.3	11.4	12.3	13.2	14.0	14.7	15.5											
Oppressed (55 trees).	½	1.5	3.4	4.9	6.4	7.6	8.7	10.2	11.4	12.8	14.2	15.6	16.7	17.8	19.0	20.2	21.2	22.3	23.1	24.2	25.0			
	18	2.1	4.2	5.7	6.9	7.8	8.8	9.7	10.9	12.1	13.1	14.2	15.2	16.0	16.8	17.7	18.4	19.0						
	34	1.8	3.6	5.0	6.5	7.9	9.2	10.4	11.6	12.7	13.7	14.6	15.5	16.3	17.1	17.8								
	50	1.6	3.4	5.2	6.7	8.3	9.8	11.2	12.4	13.5	14.5	15.4	16.3	16.8										
	66	2.2	4.6	6.4	8.1	9.4	10.7	11.8	12.7	13.4	14.0	14.4												

DIAMETER ACCRETION, IN INCHES, FOR DECADES—

Character of growth.	Height of section from ground.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Feet.																							
Dominant (68 trees).	½	1.6	1.7	1.5	1.4	1.3	1.3	1.5	1.7	2.2	2.4	2.3	2.1	2.1	2.0	1.7	1.6	1.6	1.5	1.3	1.2			
	18	2.1	2.1	1.6	1.4	1.4	1.5	1.6	1.6	1.5	1.6	1.5	1.4	1.1	1.1	1.1	1.0	0.9	0.9	0.8				
	34	2.2	2.2	2.0	1.9	1.8	1.8	1.6	1.6	1.5	1.3	1.1	1.0	1.0	0.9	0.9	0.8	0.8						
	50	2.4	2.6	2.4	2.1	1.8	1.7	1.5	1.3	1.3	1.1	1.0	1.0	0.8	0.8	0.8	0.8							
	66	2.4	2.6	2.2	2.0	1.8	1.5	1.4	1.2	1.1	1.0	0.9	0.7	0.6	0.6									
	82	2.3	2.1	1.7	1.5	1.4	1.3	1.1	0.9	0.9	0.8	0.7	0.8											
Oppressed (55 trees).	½	1.5	1.9	1.5	1.5	1.2	1.1	1.5	1.2	1.4	1.4	1.4	1.1	1.1	1.2	1.2	1.0	1.1	1.1	0.8	0.8			
	18	2.1	2.1	1.5	1.2	0.9	1.0	0.9	1.2	1.2	1.0	1.1	1.0	0.8	0.8	0.9	0.7	0.6						
	34	1.8	1.8	1.4	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.8	0.7								
	50	1.6	1.8	1.8	1.5	1.6	1.5	1.4	1.2	1.1	1.0	0.9	0.9	0.5										
	66	2.2	2.4	1.8	1.7	1.3	1.3	1.1	0.9	0.7	0.6	0.4												

CORRESPONDING AREA ACCRETION, IN SQUARE FEET, FOR DECADES—

Character of growth.	Height of section from ground.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Feet.																							
Dominant (68 trees).	½	0.01	0.05	0.07	0.08	0.10	0.11	0.16	0.20	0.32	0.40	0.45	0.45	0.51	0.53	0.48	0.48	0.51	0.50	0.40	0.43			
	18	.02	.08	.08	.10	.12	.16	.19	.21	.23	.28	.28	.28	.24	.25	.26	.26	.23	.25	.22				
	34	.03	.08	.11	.16	.18	.21	.22	.25	.26	.25	.22	.21	.22	.21	.22	.21	.21						
	50	.03	.11	.16	.19	.21	.22	.23	.21	.23	.22	.20	.21	.18	.19	.19	.21							
	66	.03	.11	.14	.18	.20	.19	.20	.19	.19	.18	.18	.14	.12	.13									
	82	.03	.08	.09	.11	.13	.14	.13	.11	.13	.12	.11	.13											
Oppressed (55 trees).	½	.01	.05	.07	.09	.02	.10	.16	.14	.18	.21	.23	.19	.21	.24	.25	.23	.26	.28	.20	.22			
	18	.02	.08	.08	.08	.07	.09	.09	.14	.15	.13	.17	.16	.14	.14	.17	.14	.12						
	34	.02	.05	.07	.09	.11	.12	.13	.14	.15	.14	.14	.15	.14	.14	.14	.14							
	50	.01	.05	.09	.09	.13	.15	.16	.16	.15	.16	.14	.16	.09										
	66	.03	.08	.11	.14	.12	.14	.14	.12	.10	.09	.06												

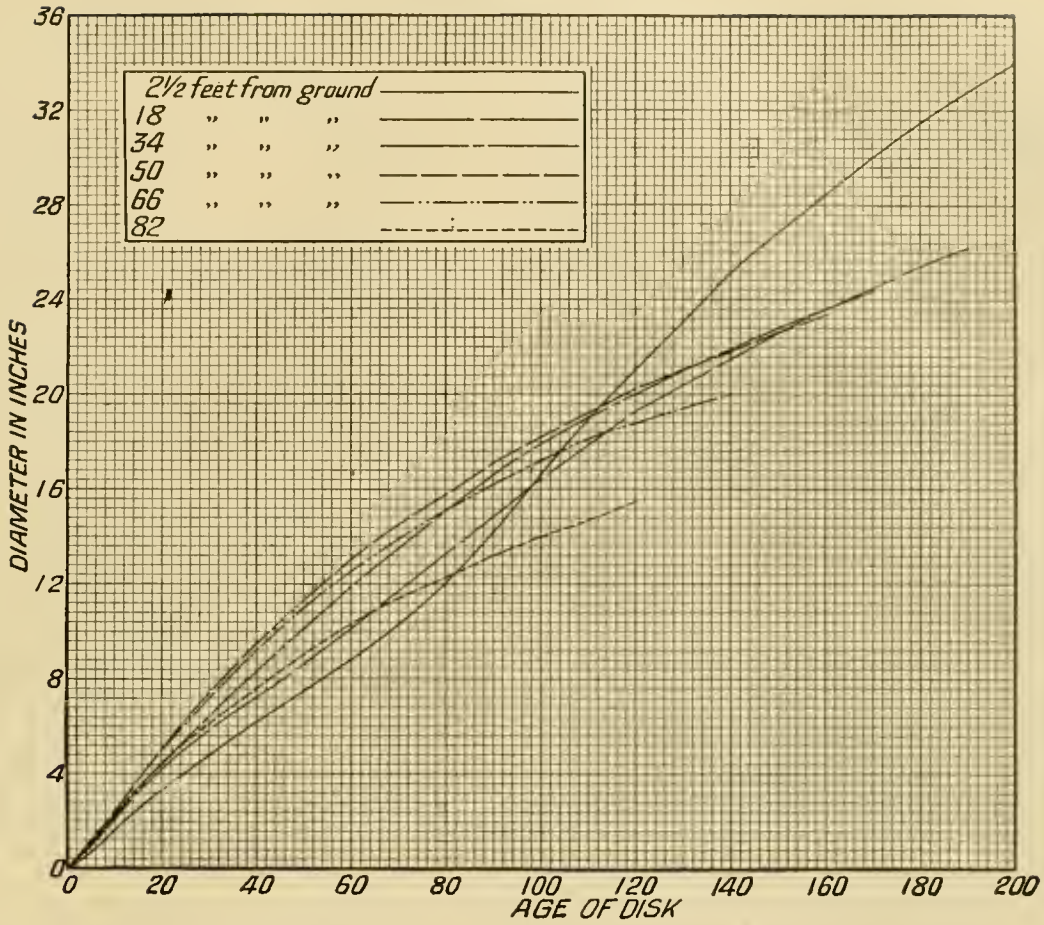


FIG. 34.—Diagram showing diameter growth of dominant trees at various heights from ground in Wisconsin.

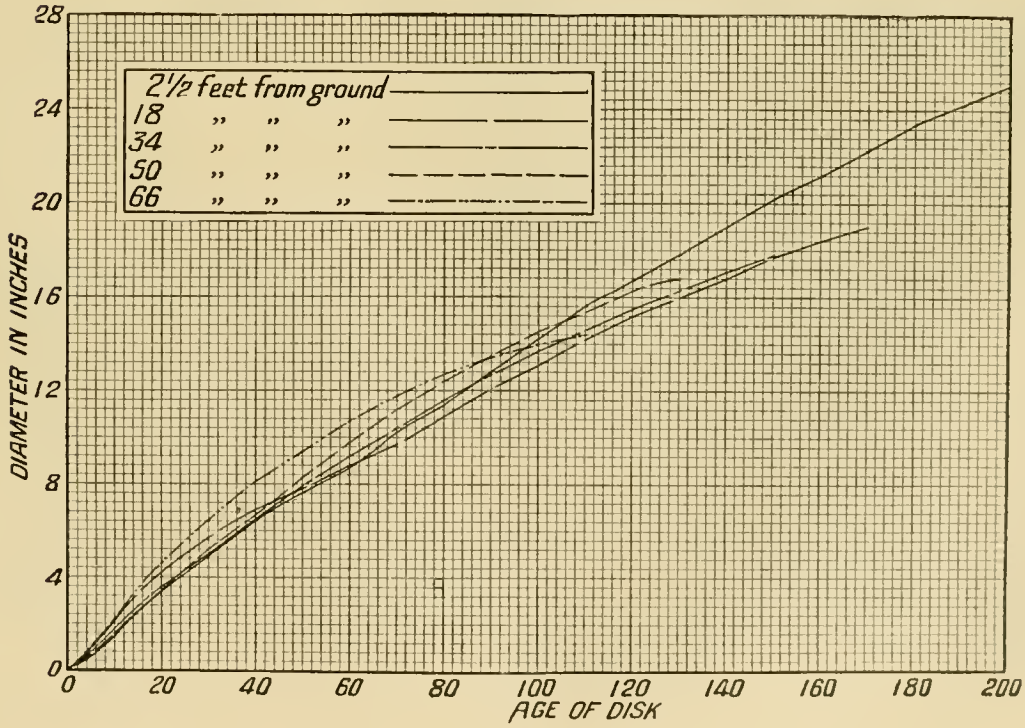


FIG. 35.—Diagram showing diameter growth of oppressed trees at various heights from ground in Wisconsin.

TABLE V.—*Growth of diameter and cross-section area at various heights from the ground*—Continued.

(3) AVERAGE FOR PENNSYLVANIA.

DIAMETER OF SECTION, IN INCHES, AT AGE (YEARS) OF

Character of growth	Height of section from ground	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230
	Feet.																							
Dominant (51 trees).	2½	2.0	4.4	7.1	9.5	11.5	13.4	15.0	16.5	18.0	19.5	21.0	22.4	23.6	24.9	26.0	27.1	28.2	29.3	30.4	31.5	32.7	33.9	34.9
	18	3.4	6.4	8.5	10.3	11.8	13.0	14.1	15.2	16.2	17.2	18.2	19.1	20.0	20.8	21.5	22.2	23.0	23.8	24.6	25.4	25.9	26.4	
	34	3.2	6.1	8.3	9.9	11.3	12.5	13.6	14.7	15.7	16.7	17.6	18.4	19.3	20.1	20.9	21.6	22.3	23.1	24.0	24.7	25.3		
	50	2.7	5.6	7.8	9.4	10.7	11.9	13.1	14.2	15.2	16.0	16.7	17.4	18.2	18.9	19.7	20.5	21.2	21.9	22.6	23.3			
	66	2.5	5.0	7.0	8.7	10.1	11.6	12.8	13.9	14.9	15.8	16.7	17.5	18.3	19.1	19.9	20.6	21.3	21.8					
	82	2.2	4.4	6.2	7.8	9.2	10.5	11.6	12.7	13.7	14.5	15.3	16.1	16.9	17.7	18.1	19.1							
	100	1.8	3.7	5.3	6.8	8.1	9.3	10.4	11.6	12.6	13.6	14.6	15.5	16.4	17.2									
	115	1.4	2.9	4.4	5.6	6.9	8.1	9.3	10.4	11.3	12.1													
Codominant (78 trees).	2½	1.6	3.5	5.4	7.2	8.7	10.2	11.6	12.9	14.2	15.5	16.8	18.2	19.3	20.3	21.3	22.3	23.2	24.0	24.8	25.5	26.2	27.0	27.8
	18	2.4	4.8	6.5	8.0	9.1	10.1	11.2	12.3	13.2	14.1	14.9	15.8	16.5	17.2	17.8	18.4	19.1	19.7	20.3	21.0	21.6	22.2	
	34	2.3	4.6	6.4	7.8	9.0	10.1	11.1	12.0	12.8	13.6	14.4	15.1	15.8	16.5	17.1	17.8	18.4	19.1	19.7	20.4	21.0		
	50	2.3	4.1	6.2	7.9	9.3	10.5	11.5	12.5	13.4	14.2	14.9	15.6	16.3	16.9	17.6	18.2	18.9	19.5	20.1				
	66	2.1	4.1	5.8	7.2	8.5	9.6	10.6	11.5	12.3	13.1	13.9	14.6	15.3	15.9	16.6	17.2	17.8						
	82	1.6	3.1	4.5	5.7	6.8	7.8	8.7	9.6	10.4	11.1	11.8	12.4	13.0	13.7									
	98	1.4	2.5	3.8	5.0	6.1	7.1	8.0																
	114	1.0	2.0	3.1	4.2	5.2																		

DIAMETER ACCRETION, IN INCHES, FOR DECADES—

Character of growth.	Height of section from ground.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Feet																							
Dominant (51 trees).	2½	2.0	2.4	2.7	2.4	2.0	1.9	1.6	1.5	1.5	1.5	1.5	1.4	1.2	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.0
	18	3.4	3.0	2.1	1.8	1.5	1.2	1.1	1.1	1.0	1.0	1.0	.9	.9	.8	.7	.7	.8	.8	.8	.8	.5	.5	
	34	3.2	2.9	2.2	1.6	1.4	1.2	1.1	1.1	1.0	1.0	.9	.8	.8	.8	.8	.7	.7	.8	.9	.7	.6		
	50	2.7	2.9	2.2	1.6	1.3	1.2	1.2	1.1	1.0	.8	.7	.7	.8	.7	.8	.8	.7	.7	.7	.7			
	66	2.5	2.5	2.0	1.7	1.6	1.3	1.2	1.1	1.0	.9	.9	.8	.8	.8	.8	.7	.7	.5					
	82	2.2	2.2	1.8	1.6	1.4	1.3	1.1	1.1	1.0	.8	.8	.8	.8	.8	.7	.7							
	100	1.8	1.9	1.6	1.5	1.3	1.2	1.1	1.2	1.0	1.0	1.0	.9	.9	.8									
	115	1.4	1.5	1.5	1.2	1.3	1.2	1.2	1.1	.9	.8													
Codominant (78 trees).	2½	1.6	1.9	1.9	1.8	1.5	1.5	1.4	1.3	1.3	1.3	1.3	1.4	1.1	1.0	1.0	1.0	0.9	0.8	0.8	0.7	0.7	0.8	0.8
	18	2.4	2.4	1.7	1.5	1.1	1.0	1.1	1.1	.9	.9	.8	.9	.7	.7	.6	.6	.7	.6	.6	.7	.6	.6	
	34	2.3	2.3	1.8	1.4	1.2	1.1	1.0	.9	.8	.8	.8	.7	.7	.7	.6	.7	.6	.7	.6	.7	.6		
	50	2.3	2.1	1.8	1.7	1.4	1.2	1.0	1.0	.9	.8	.7	.7	.7	.6	.7	.6	.7	.6	.6				
	66	2.1	2.0	1.7	1.4	1.3	1.1	1.0	.9	.8	.8	.8	.7	.7	.6	.7	.6	.6						
	82	1.6	1.5	1.4	1.2	1.1	1.0	.9	.9	.8	.7	.7	.6	.6	.7									
	98	1.4	1.1	1.3	1.2	1.1	1.0	.9																
	114	1.0	1.0	1.1	1.1	1.0																		

CORRESPONDING AREA ACCRETION, IN SQUARE FEET FOR DECADES—

Character of growth.	Height of section from ground.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Feet.																							
Dominant (51 trees).	2½	0.02	0.08	0.17	0.22	0.23	0.25	0.25	0.26	0.29	0.30	0.33	0.34	0.30	0.34	0.31	0.31	0.34	0.34	0.36	0.37	0.42	0.44	0.37
	18	.06	.16	.17	.19	.18	.16	.16	.17	.16	.18	.17	.20	.18	.19	.18	.16	.17	.19	.21	.21	.22	.14	.14
	34	.05	.15	.17	.16	.17	.15	.16	.17	.16	.18	.17	.16	.18	.17	.18	.16	.17	.20	.23	.19	.16		
	50	.04	.13	.16	.15	.14	.15	.16	.17	.16	.14	.12	.13	.16	.14	.17	.17	.16	.16	.17	.16			
	66	.03	.11	.13	.14	.17	.15	.16	.16	.16	.15	.16	.15	.16	.16	.17	.18	.13	.12					
	82	.03	.07	.11	.12	.13	.14	.13	.15	.14	.13	.13	.13	.15	.15	.14	.14							
	100	.02	.05	.08	.10	.11	.11	.12	.14	.13	.15	.15	15	16	.14									
	115	.01	.03	.07	07	.09	.10	.11	.12	.11	.10													
Codominant (78 trees).	2½	.01	.06	.09	.12	.13	.16	.16	.18	.19	.21	.23	.27	.22	.22	22	.24	.22	21	.21	.20	19	.24	.23
	18	.03	.09	.11	.12	.10	.11	.12	14	.13	.13	.13	.15	.12	.13	.12	.12	.14	.13	.13	.15	.14	.15	
	34	.03	.08	.11	.11	.11	.12	.11	11	.11	12	12	.11	12	.12	.11	.14	.12	.14	.13	.15	.13		
	50	.03	.07	.11	.13	.13	.13	.12	13	.13	12	.11	.12	.12	.11	.13	.12	.14	.12	.13				
	66	.02	.07	.09	.10	.11	.11	.11	11	.10	.11	.12	.11	.12	.10	.12	.11	.12						
	82	.01	.04	.06	.07	.07	.08	.08	09	.09	.08	.09	08	.08	.10									
	98	.01	.02	.06	06	.06	.07	.08																
	114	.01	.01	.03	05	.05																		

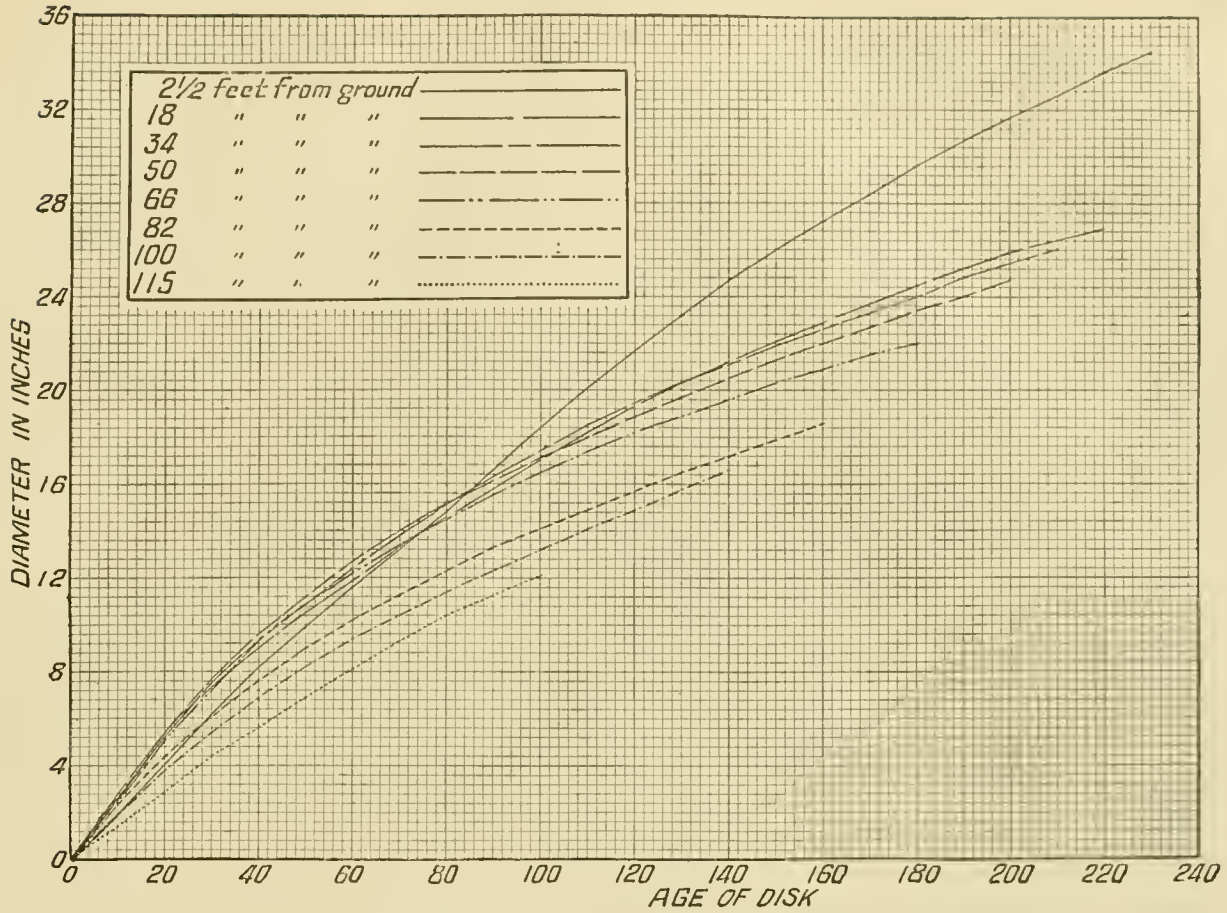


FIG. 36.—Diagram showing diameter growth of dominant trees at various heights from ground in Pennsylvania.

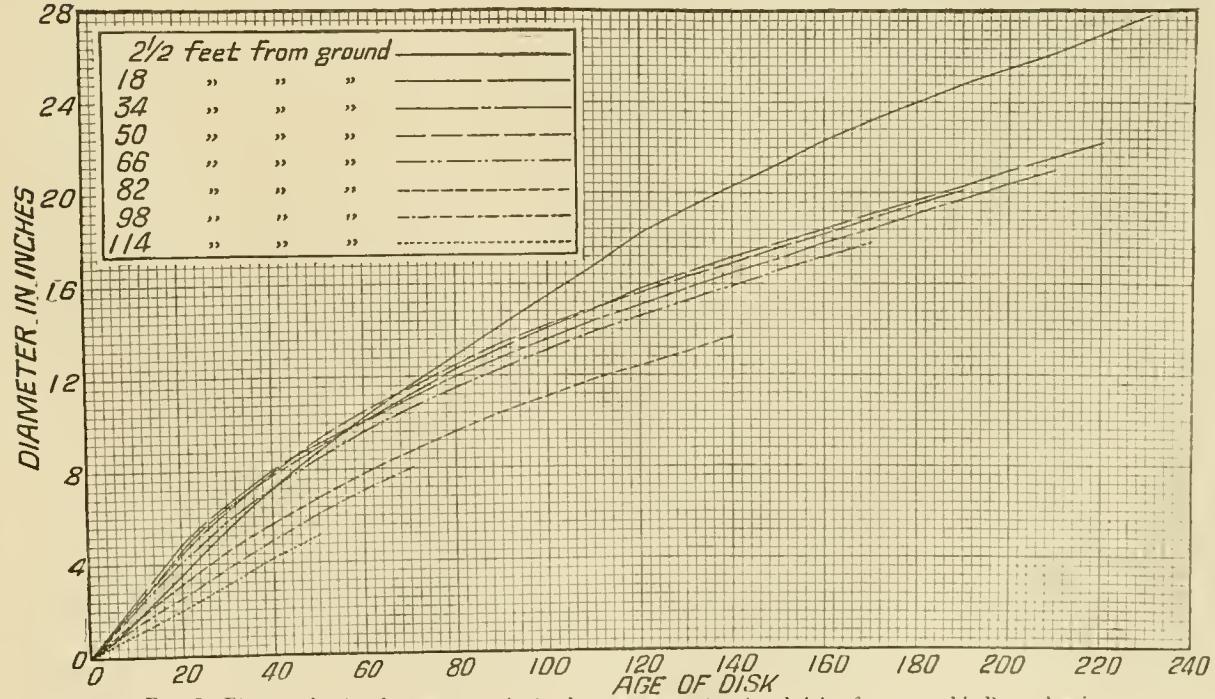


FIG. 37.—Diagram showing diameter growth of codominant trees at various heights from ground in Pennsylvania.

TABLE V.—*Growth of diameter and cross-section area at various heights from the ground*—Continued.

(4) AVERAGE FOR MICHIGAN.

DIAMETER OF SECTION, IN INCHES, AT AGE (YEARS) OF—

Character of growth.	Height of section from ground.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230
	Feet.																							
Dominant (75 trees).	½	2.0	4.4	6.6	8.7	10.6	12.4	14.0	15.6	17.2	18.7	20.0	21.2	22.3	23.5	24.5	25.5	26.5	27.5	28.4	29.1	29.8	30.6	31.4
	18	2.8	5.6	7.7	9.6	11.3	12.8	14.2	15.5	16.7	17.7	18.7	19.7	20.6	21.5	22.4	23.2	23.9	24.6	25.2	25.8	26.3	26.8	
	34	2.8	5.6	7.9	9.8	11.4	12.8	14.2	15.3	16.3	17.3	18.5	19.4	20.2	21.0	21.7	22.4	23.1	23.7	24.3	24.8			
	50	2.8	5.7	8.0	10.1	11.8	13.3	14.5	15.5	16.5	17.1	18.3	19.2	20.1	20.9	21.6	22.2	22.8	23.4	23.9				
	66	2.5	5.2	7.3	8.8	10.1	11.3	12.4	13.5	14.5	15.5	16.5	17.4	18.1	18.8	19.4	19.9	20.4						
	82	2.3	4.2	5.9	7.4	8.7	9.7	10.7	11.6	12.7	13.6	14.4	15.1	15.8	16.4	17.1								
	100	2.1	4.0	5.5	7.0	8.2	9.4	10.3	11.1	11.9	12.6	13.3												
Codominant (28 trees).	½	1.5	3.4	5.1	6.7	8.3	9.6	11.0	12.6	14.1	15.4	16.7	18.1	19.4	20.5	21.6	22.8	23.8	24.7	25.6	26.4	27.1	27.7	28.3
	18	2.3	4.9	6.8	8.4	9.8	11.2	12.4	13.5	14.6	15.6	16.6	17.6	18.5	19.2	19.9	20.6	21.3	21.9	22.4	22.9	23.4	23.9	
	34	2.8	5.5	7.4	9.1	10.6	11.9	13.1	14.2	15.2	16.1	16.9	17.7	18.4	19.1	19.7	20.3	20.9	21.4	21.8				
	50	2.9	5.3	7.5	9.2	10.7	12.0	13.0	14.0	14.9	15.8	16.6	17.4	18.1	18.8	19.4	19.9	20.5	21.0					
	66	2.2	4.3	6.2	7.7	9.0	10.0	11.0	11.8	12.5	13.3	14.1	14.8	15.4	15.9	16.4	16.9							
	82	2.2	4.4	6.0	7.5	8.8	9.9	10.9	11.8	12.6	13.3	14.0	14.6	15.1	15.7									
	100	1.7	3.2	4.5	5.6	6.7	7.8	8.7	9.5	10.3	11.0	11.7												
Oppressed (36 trees).	½	1.2	2.6	4.4	6.1	7.5	8.8	10.1	11.3	12.8	14.0	15.3	16.5	17.7	18.7	19.7	20.6	21.4	22.1	22.9	23.6	24.2	24.7	25.2
	18	2.0	4.0	5.6	7.0	8.1	9.2	10.0	11.0	12.1	13.1	14.0	14.7	15.5	16.2	16.8	17.3	17.8	18.3	18.7	19.1			
	34	2.5	5.1	7.2	9.0	10.3	11.4	12.4	13.3	14.0	14.6	15.2	15.8	16.4	16.9	17.4	17.8	18.2	18.5					
	50	2.5	5.0	6.9	8.3	9.5	10.6	11.6	12.4	13.2	13.9	14.6	15.2	15.8	16.4	16.8	17.2	17.7						
	66	2.5	4.7	6.3	7.6	8.7	9.7	10.6	11.4	12.1	12.7	13.3	13.8	14.3	14.8	15.2								
	82	2.3	4.1	5.7	6.9	7.8	8.4	9.1	9.8	10.2	10.6	11.0	11.4	11.9										
	100	1.9	3.8	5.0	5.9	6.7	7.4	8.1	8.6	9.0														

DIAMETER ACCRETION, IN INCHES, FOR DECADES—

Character of growth.	Height of section from ground.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Feet.																							
Dominant (75 trees).	½	2.0	2.4	2.2	2.1	1.9	1.8	1.6	1.6	1.6	1.5	1.3	1.2	1.1	1.2	1.0	1.0	1.0	1.0	0.9	0.7	0.7	0.8	0.8
	18	2.8	2.8	2.1	1.9	1.7	1.5	1.4	1.3	1.2	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.7	0.7	0.6	0.6	0.5	0.5	
	34	2.8	2.8	2.3	1.9	1.6	1.4	1.4	1.1	1.0	1.0	1.2	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.5			
	50	2.8	2.9	2.3	2.1	1.7	1.5	1.2	1.0	1.0	0.9	0.9	0.9	0.9	0.8	0.7	0.6	0.6	0.6	0.5				
	66	2.5	2.7	2.1	1.5	1.3	1.2	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.7	0.7	0.6	0.5	0.5					
	82	2.3	1.9	1.7	1.5	1.3	1.0	1.0	0.9	1.1	0.9	0.8	0.7	0.7	0.6	0.7								
	100	2.1	1.9	1.5	1.5	1.2	1.2	0.9	0.8	0.8	0.7	0.7												
Codominant (28 trees).	½	1.5	1.9	1.7	1.6	1.6	1.3	1.4	1.6	1.5	1.3	1.3	1.4	1.3	1.1	1.1	1.2	1.0	0.9	0.9	0.8	0.7	0.6	0.6
	18	2.3	2.6	1.9	1.6	1.4	1.4	1.2	1.1	1.1	1.0	1.0	1.0	0.9	0.7	0.7	0.7	0.7	0.6	0.5	0.5	0.5	0.5	
	34	2.8	2.7	1.9	1.7	1.5	1.3	1.2	1.1	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.4				
	50	2.9	2.4	2.2	1.7	1.5	1.3	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.5	0.6	0.5					
	66	2.2	2.1	1.9	1.5	1.3	1.0	1.0	0.8	0.7	0.8	0.8	0.7	0.6	0.5	0.5	0.5	0.4						
	82	2.2	2.2	1.6	1.5	1.3	1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.5	0.6									
	100	1.7	1.5	1.3	1.1	1.1	1.1	0.9	0.8	0.8	0.7	0.7												
Oppressed (36 trees).	½	1.2	1.4	1.8	1.7	1.4	1.3	1.3	1.2	1.5	1.2	1.3	1.2	1.2	1.0	1.0	0.9	0.8	0.7	0.8	0.7	0.6	0.5	0.5
	18	2.0	2.0	1.6	1.4	1.1	1.1	0.8	1.0	1.1	1.0	0.9	0.7	0.8	0.7	0.6	0.5	0.5	0.5	0.4	0.4			
	34	2.5	2.6	2.1	1.8	1.3	1.1	1.0	0.9	0.7	0.6	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.3					
	50	2.5	2.5	1.9	1.4	1.2	1.1	1.0	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.4	0.4	0.5						
	66	2.5	2.2	1.6	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.4								
	82	2.3	1.8	1.6	1.2	0.9	0.6	0.7	0.7	0.4	0.4	0.4	0.4	0.5										
	100	1.9	1.9	1.2	0.9	0.8	0.7	0.7	0.5	0.4														

CORRESPONDING AREA ACCRETION, IN SQUARE FEET, FOR DECADES

Character of growth.	Height of section from ground	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Feet.																							
Dominant (75 trees).	½	0.02	0.08	0.14	0.17	0.20	0.23	0.23	0.26	0.28	0.30	0.27	0.27	0.26	0.30	0.26	0.28	0.28	0.29	0.28	0.22	0.22	0.27	0.27
	18	.04	.13	.15	.18	.20	.19	.21	.21	.21	.19	.20	.21	.22	.18	.22	.19	.18	.19	.16	.17	.14	.15	
	34	.04	.13	.17	.18	.19	.18	.21	.18	.17	.18	.24	.18	.17	.18	.17	.17	.17	.15	.16	.13			
	50	.04	.14	.17	.21	.20	.20	.19	.16	.17	.17	.18	.18	.19	.18	.16	.15	.14	.16	.12				
	66	.03	.12	.14	.13	.14	.14	.14	.15	.16	.16	.17	.17	.14	.14	.12	.11	.11						
	82	.03	.07	.09	.11	.11	.10	.11	.11	.15	.13	.12	.11	.12	.11	.12								
	100	.02	.07	.07	.11	.09	.12	.10	.09	.10	.10	.09	.08											
Codominant (28 trees).	½	.01	.05	.08	.10	.13	.13	.16	.20	.22	.21	.23	.27	.26	.24	.25	.29	.26	.24	.24	.23	.20	.18	.19
	18	.03	.10	.12	.13	.14	.16	.16	.15	.17	.17	.17	.19	.18	.14	.15	.18	.13	.14	.13	.12	.13		
	34	.04	.12	.14	.15	.16	.16	.17	.16	.16	.15	.15	.15	.14	.14	.13	.13	.13	.11	.10				
	50	.05	.10	.16	.15	.16	.16	.14	.15	.14	.15	.14	.15	.14	.14	.12	.11	.13	.11					
	66	.03	.07	.11	.11	.12	.10	.12	.10	.09	.11	.12	.11	.10	.09	.09	.09							
	82	.03	.07	.10	.11	.11	.11	.12	.11	.11	.09	.11	.09	.08	.10									
	100	.02	.04	.05	.06	.07	.09	.08	.08	.09	.08	.09												
Oppressed (36 trees).	½	.01	.03	.06	.10	.11	.11	.14	.14	.19	.18	.21	.20	.23	.20	.21	.22	.16	.16	.20	.18	.15	.14	.13
	18	.02	.07	.08	.10	.09	.10	.08	.12	.14	.14	.13	.11	.13	.12	.11	.09	.10	.10	.08	.08			
	34	.03	.11	.14	.16	.14	.13	.12	.13	.11	.09	.10	.10	.11	.09	.09	.08	.08	.06					
	50	.03	.11	.12	.12	.11	.12	.12	.11	.11	.10	.11	.10	.10	.11	.07	.07	.10						
	66	.03	.09	.10	.09	.10	.10	.10	.10	.09	.08	.08	.08	.07	.08	.07								
	82	.03	.06	.09	.08	.07	.05	.07	.07	.05	.04	.05	.05	.06										
	100	.02	.06	.06	.05	.05	.06	.06	.04	.04														

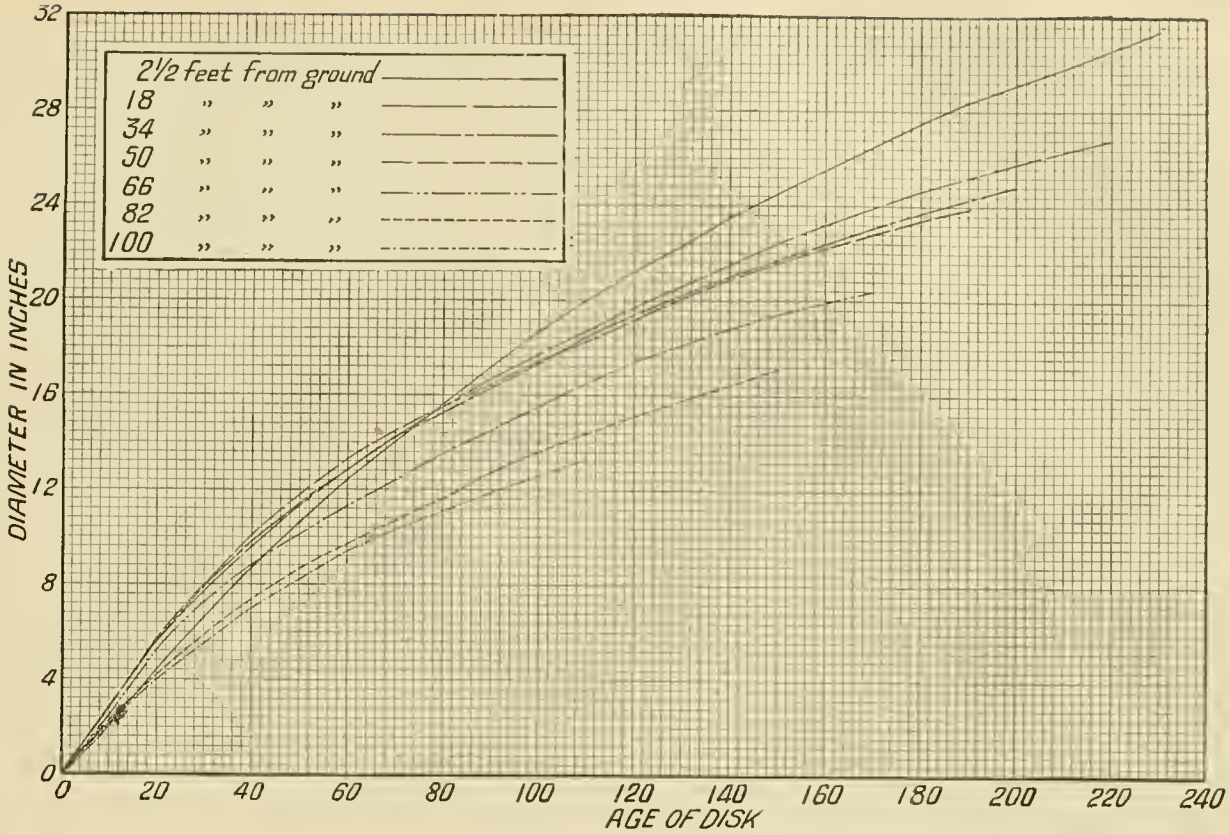


FIG. 38.—Diagram showing diameter growth of dominant trees at various heights from ground in Michigan.

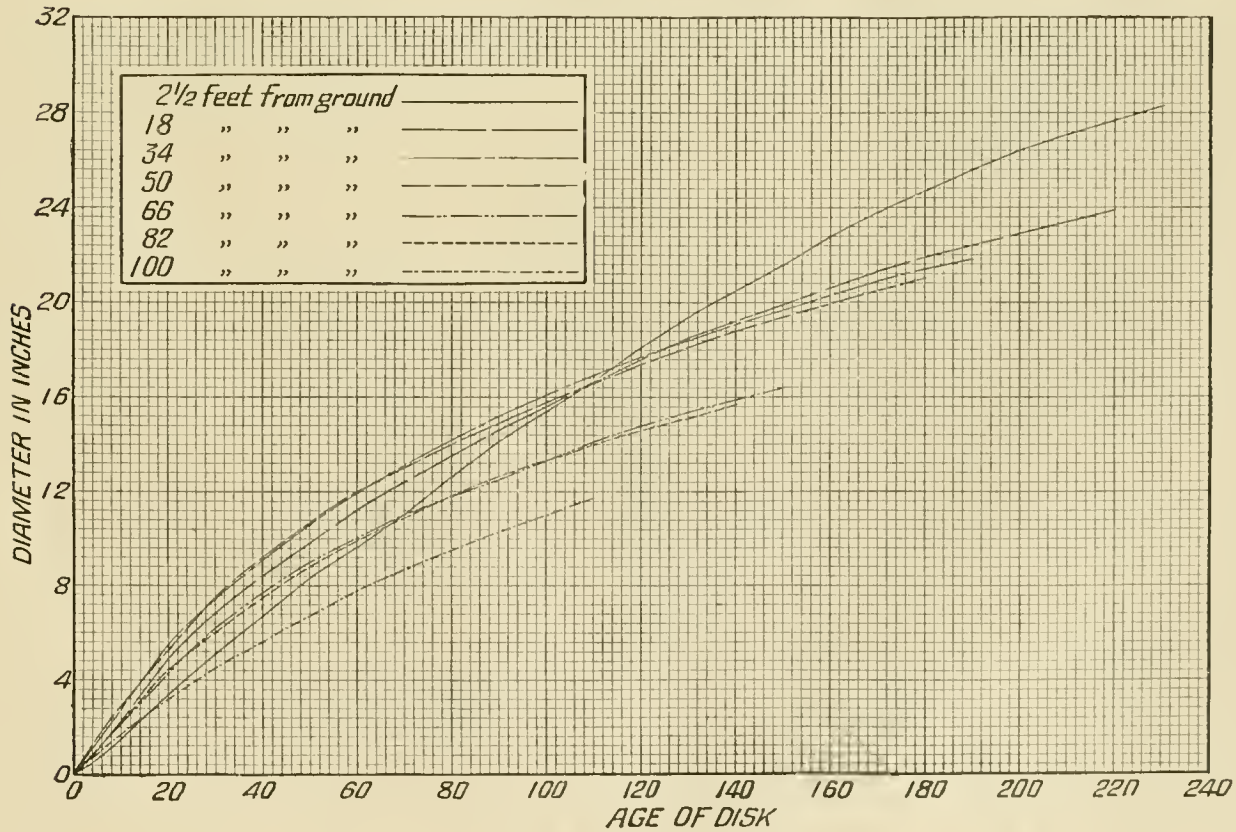


FIG. 39.—Diagram showing diameter growth of codominant trees at various heights from ground in Michigan.

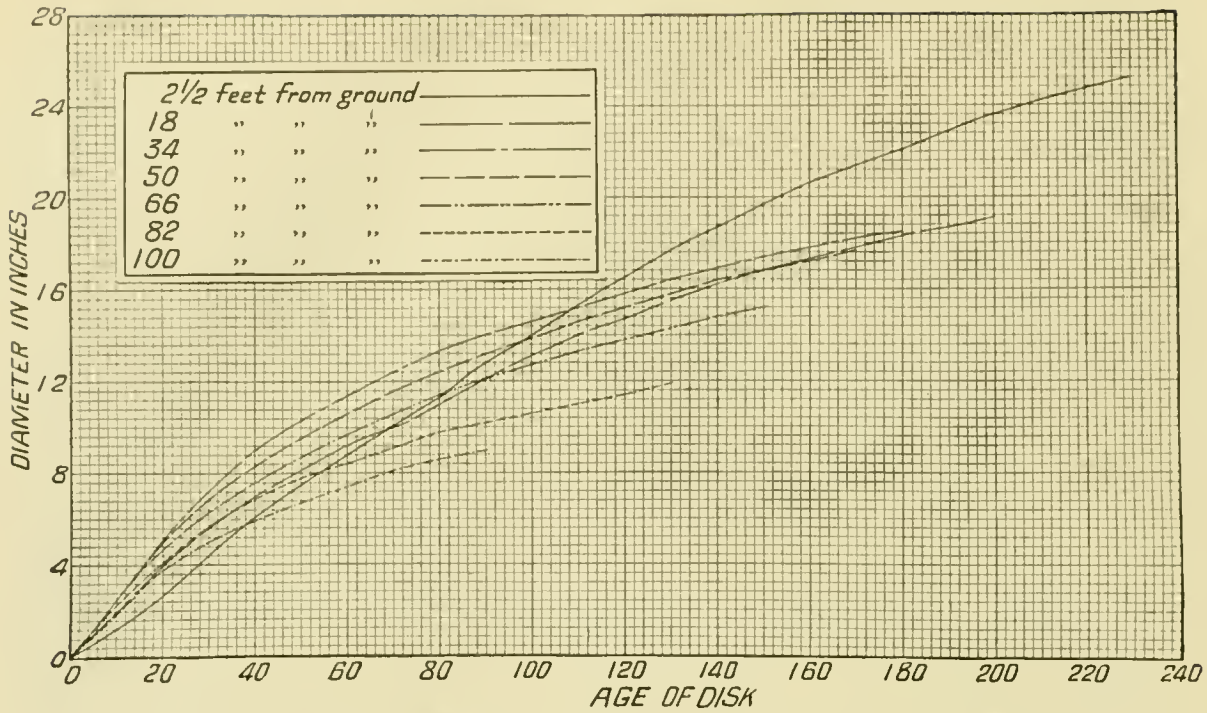


FIG. 40.—Diagram showing diameter growth of oppressed trees at various heights from ground in Michigan.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees.*

A.—MICHIGAN:

(1) SITE *a*:

Presque Isle County.

[700 to 800 feet above sea level.]

Sample area: 1 acre.

Soil: Yellow or gray sand, moderately loose, deep; subsoil with small stones, surface cover of brakes, huckleberry, etc.,

Forest conditions: Red Pine (61 per cent), mixed with White Pine (36 per cent), and occasional Maple, Poplar, Cedar (3 per cent), on level.

Age of pine: 100 to 150 years.
Density of crown cover: 0.6.

Number of trees: 181.

Classification:

	White Pine.	Red Pine.
Dominant ..... per cent..	40	46
Oppressed ..... do....	27	26
Suppressed ..... do....	43	28

ACRE YIELD.

White Pine.					Red Pine.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
4	3 to 6		.....		9	.....	
17	6 to 10		170		25	6 to 10	
1	10		18		4	10	
4	11		100		7	11	
2	12		60		7	12	
5	13		175		5	13	80
6	14		240		7	14	to
7	15	80	322		9	15	100
4	16	to	232		13	16	
5	17	100	325		12	17	
3	18		216		9	18	
2	19		158		3	19	
2	21		186		3	20	
3	22		303				
1	24		119				
2	27		366				
68 trees:					113 trees:		
Total cubic feet			2,990		Total cubic feet		3,813
Total feet B. M			14,350		Total feet B. M.		18,300

Total yield: Pine, 32,650 feet B. M., of which White Pine 44 per cent.
Average annual accretion: White Pine, 57 cubic feet.
272 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

MEASUREMENTS OF SAMPLE TREES.

Age class: 80 to 100 years.

DOMINANT GROWTH.

Tree number	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
13	100	19.0	94	5.2	75.4	0.40	0.52	2.0	1.50	0.75
42	100	20.2	95	4.9	99.6	.48	.42	.8	.80	1.00
29	95	21.5	100	4.1	115.4	.45	.48	1.0	1.15	1.21
Average...	98	20.2	96	4.7	96.8	.44	.47	1.3	1.15	.99

OPPRESSED GROWTH.

66	98	14.5	78	5.9	46.9	0.52	0.42	2.2	1.03	0.47

SUPPRESSED GROWTH.

19	92	10.5	72.0	8.2	20.6	0.47	0.26	1.2	0.25	0.22
11	84	10.0	73.0	7.6	20.9	.53	.48	3.7	.77	.25
Average...	88	10.2	72.5	7.9	20.7	.50	.37	2.4	.51	.23

Age class: 100 to 150 years.

DOMINANT GROWTH.

1	123	20.0	10.2	5.5	89.7	0.40	0.54	2.9	2.60	0.73
22	101	20.8	90.0	4.7	92.7	.42	.51	2.0	1.85	.91
48	105	20.5	99.0	5.1	96.7	.42	.44	1.3	1.26	.92
47	104	22.7	94.0	4.7	103.0	.39	.59	1.5	1.55	.99
Average...	108	21.0	96.0	5.0	95.5	.41	.52	1.9	1.81	.89
5	149	20.2	105.0	7.6	88.9	.39	.50	2.0	1.78	.60
6	135	21.0	114.0	6.2	107.9	.39	.57	2.2	2.37	.80
35	135	22.0	121.0	5.5	139.6	.40	.43	1.5	2.10	1.03
Average...	139.7	21.1	113.0	6.4	112.1	.39	.50	1.9	2.08	.81

OPPRESSED GROWTH.

9	102	16.0	85.0	6.6	48.8	0.41	0.46	2.5	1.22	0.47
31	102	15.1	86.0	6.7	49.4	.46	.40	1.4	.69	.48
45	102	17.0	84.0	6.0	58.5	.44	.61	1.7	.99	.57
43	105	16.8	87.0	6.1	67.3	.49	.42	.7	.47	.64
Average...	103	16.2	85.5	6.3	56.0	.45	.47	1.6	.84	.54
4	127	17.0	88.0	6.7	56.9	.41	.54	5.2	2.96	.44
40	134	15.0	94.0	8.6	57.6	.50	.30	2.2	1.26	.43
3	147	18.0	91.0	7.9	66.0	.41	.44	4.9	3.23	.44
Average...	136	16.7	91.0	7.7	60.2	.44	.43	4.1	2.48	.44

SUPPRESSED GROWTH.

39	127	11.0	69	1.2	24.6	0.54	0.22	3.2	0.79	0.19

Age class: 250 to 300 years.

DOMINANT GROWTH.

7	284	33.0	135	8.7	319.2	0.39	.....	0.6	1.91	1.12

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

(2) SITE *b*. Presque Isle County. Sample area 1 acre.

[700 to 800 feet above sea level.]

Soil: Deep, loose, gray sand covered with leaves; said to be underlaid by clay.

Age of pine 130 to 140 years.
Density of crown cover 0.7 to 0.8.
Number of trees: 181.

Forest conditions. White Pine (68 per cent), intermixed with Red Pine (14 per cent), Hemlock (18 per cent), with scattering Cedar.

Classification.

	White Pine
Dominant ..... per cent	52
Oppressed ..... do	18
Suppressed ..... do	30

ACRE YIELD.

White Pine.					Red Pine.			Hemlock.		
			Volume.							
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
28	6 to 10		280		1	6 to 10		20	6 to 10	40
5	10		95		1	14		11	10 to 14	to
6	11		192		1	15		3	14 to 18	60
7	12		266		5	16	100			
6	13		264		6	17	to			
11	14		550		1	18	120			
9	15		522		3	19				
6	16		384		2	20				
10	17	100	720		5	21				
8	18	to	640		1	22				
7	19	120	616							
6	20		690							
6	21		744							
7	22		945							
1	24		147							
1	24		153							
3	26		555							
1	27		199							
1	30		240							
129 trees:					26 trees:			34 trees		
Total cubic feet			8,202		Total cubic feet		2,140	Total cubic feet		520
Total feet B. M			39,300							

Total yield. All species, 11,162 cubic feet, of which White Pine 73 per cent.
Average annual accretion: White Pine, 63 cubic feet.
302 feet B. M.

MEASUREMENTS OF SAMPLE TREES.

Age class. 130 to 150 years.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
34	140	19.5	124	6.5	109.8	0.42	0.34	1.0	1.10	0.78
9	136	19.7	114	6.7	115.9	.49	.34	1.2	1.39	.85
33	135	20.0	115	6.2	121.5	.48	.32	1.6	1.94	.90
37	134	22.0	113	6.0	123.5	.51	.27	.7	.86	.92
36	136	22.5	123	6.5	130.1	.39	.30	1.4	1.82	.96
35	135	21.7	122	5.9	136.4	.44	.32	.7	.95	1.01
2	138	22.8	119	6.1	138.5	.40	.30	1.0	1.38	1.00
22	133	23.2	116	5.5	141.1	.42	.38	1.2	1.69	1.06
4	130	24.0	106	5.3	143.5	.43	.40	1.8	2.58	1.10
3	135	24.0	108	5.6	144.7	.42	.35	.9	1.30	1.07
1	138	23.5	113	5.7	146.5	.43	.26	1.0	1.46	1.06
16	139	25.0	122	5.2	187.3	.44	.50	1.5	2.81	1.27
Average	135.7	22.3	116	5.9	136.6	.42	.34	1.2	1.61	1.00
27	142	23.0	117	5.8	138.9	.41	.30	1.2	1.67	.98
26	142	24.0	110	5.8	140.6	.41	.39	1.6	2.11	.99
11	142	23.5	114	5.7	148.0	.43	.36	1.8	2.66	1.04
20	142	22.0	119	6.0	157.3	.49	.26	1.5	2.36	1.11
30	143	24.2	116	5.8	164.3	.45	.38	1.7	2.79	1.14
24	149	25.0	113	5.7	168.8	.46	.34	.8	1.35	1.06
5	148	26.3	115	5.5	205.4	.46	.39	1.2	2.46	1.39
Average	144	24.0	115	5.8	160.5	.44	.34	1.4	2.20	1.10

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

MEASUREMENTS OF SAMPLE TREES—Continued

OPPRESSED GROWTH.

Tree number.	Age.	Diameter (breast high).	Height	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
7	132	17.8	114	6.7	83.6	0.41	0.42	1.2	1.00	0.63
12	139	18.5	112	7.8	88.4	.42	.38	1.1	.97	.63
18	135	18.0	116	7.2	91.2	.44	.27	.9	.82	.67
28	135	17.5	110	7.3	92.0	.49	.36	1.6	1.47	.67
14	135	19.5	107	6.8	95.6	.43	.42	.5	.48	.70
29	140	18.5	102	7.5	98.2	.51	.27	1.9	1.87	.70
Average	136	18.3	110	7.2	91.5	.45	.35	1.2	1.10	.67

SUPPRESSED GROWTH.

8	131	15.0	115	8.5	66.2	0.47	0.35	1.0	0.66	0.50
32	135	17.5	(?)	7.2	73.9	(?)	(?)	2.4	1.77	.55
31	238	17.4	104	7.3	78.6	.45	.29	1.7	1.34	.57
13	131	16.4	114	7.7	79.7	.47	.28	1.3	1.04	.61
17	138	19.0	103	7.0	80.6	.39	.28	1.6	1.29	.58
Average	134.6	17.0	109	7.5	75.8	.44	.30	1.6	1.22	.56
6	142	21.0	109	7.2	121.7	.46	.44	1.5	1.82	.85
25	154	19.0	97	7.7	78.6	.41	.41	1.4	1.10	.50
Average	148	20.0	103	7.5	100.0	.43	.42	1.4	1.46	.67

(3) SITE *d*: Montmorency County.

Sample area: 1 acre.

Soil: Fresh, loose gray sand, turning brown and red below, with surface cover of brakes and checkerberry; subsoil, brown sand, sometimes loamy, and in spots clay.

Forest conditions: White Pine (54 per cent) mixed with Red Pine (35 per cent) and Hemlock (11 per cent).

Damaged by fire twelve years before; sample area shows 15 per cent dead trees and 20 per cent damaged by fire.

Age of pine: 250 to 270 years.
Density of crown cover: 0.5.

Number of trees: 113.

ACRE YIELD.

White Pine.					Red Pine.			Hemlock.		
Number of trees.	Diameter (breast high).	Height.	Volume.		Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
			Bole.	Merchantable timber.						
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
2	10	120 to 140	36		2	13	120 to 140	2	3 to 6	50 to 80
1	12		38		1	14		1	9	
3	13		159		3	15		1	11	
1	14		60		1	16		2	12	
3	15		207		3	17		6	15	
3	16		231		3	18		1	20	
1	17		86		6	19				
1	18		96		5	20				
3	19		315		4	21				
2	21		280		8	22				
6	22		906		1	23				
5	23		855		1	24				
9	24		1,611		1	30				
4	25		800							
1	26		216							
3	27		696							
2	28		498							
7	29		1,862							
2	30		560							
1	31		302							
1	33		340							
61 trees: Total cubic feet 10,154; Total feet B. M. 60,900					39 trees: Total cubic feet 5,256; Total feet B. M. 25,200			13 trees.		

Total yield: Pine, 86,100 feet B. M., of which White Pine 66 per cent.
Average annual accretion: Pine, 59 cubic feet.
331 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A. MICHIGAN—Continued.

(1) SITE *c*: Montmorency County.

Sample area: one-half acre.

Soil: Brown or red sandy loam, light, loose, dry, with stones, and surface cover of brakes and other weeds.

Forest conditions: Red Pine (59 per cent) mixed with White Pine (41 per cent); no undergrowth; level.

Age of pine: 100 to 120 years.
Density of crown cover: 0.5.
Number of trees: 110.

Classification:

	White Pine.	Red Pine.
Dominant.....per cent..	65	60
Oppressed.....do....	18	34
Suppressed.....do....	17	6

HALF-ACRE YIELD.

White Pine.					Red Pine.		
			Volume.				
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
2	3 to 6	80 to 100	.....		4	3 to 6	80 to 100
2	6 to 10		20		6	6 to 10	
4	10		72		4	10	
2	11		56		2	11	
2	12		68		6	12	
6	13		234		1	13	
8	14		360		6	14	
2	15		104		2	15	
6	16		348		2	16	
2	17		130		4	17	
4	18		288		10	18	
6	19		474		6	19	
					4	20	
					2	21	
					2	22	
46 trees:					64 trees:		
Total cubic feet.....			2,154		Total cubic feet.		3,532
Total feet B. M.....			9,030		Total feet B. M.		14,800

Total yield: Pine, 23,830 feet B. M., of which White Pine 38 per cent.
Average annual accretion: Pine, 51 cubic feet.
217 feet B. M.

MEASUREMENTS OF SAMPLE TREES.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
								Per cent.	*Cu. feet.*	*Cu. feet.*
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. feet.*					
3.....	120	18	96	6.5	71.6	0.42	0.41	1.1	0.79	0.60

OPPRESSED GROWTH.

1.....	118	11	95	7.4	55.0	0.53	0.31	1.1	0.60	0.46

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

(5) SITE *f* — Montmorency County. — Sample area: 1 acre.

Soil: Brown, dry sand, with stones, and surface cover of brakes and grass.
Forest conditions: Red Pine (94 per cent) with scattering White Pine (6 per cent) on a level plain; no undergrowth save very small shrubs of scattered Oak (characteristic of this locality). About 15 per cent of trees injured by fire in 1891.

Age of pine: 160 to 180 years
Density of crown cover: 0.6.
Number of trees: 115.

Classification:

	Red Pine.
Dominant ..... per cent ..	72
Oppressed ..... do	13
Suppressed ..... do	15

ACRE YIELD.

White Pine.					Red Pine.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
1	15	90 to 100	52		1	10	90 to 100
2	16		116		1	11	
1 (dead)	18		.....		5 (2 dead)	12	
1 (dead)	21		.....		5	13	
1	22		112		8 (3 dead)	14	
1	23		122		13 (1 dead)	15	
					18 (4 dead)	16	
					20 (3 dead)	17	
					24 (4 dead)	18	
					5	19	
					5	20	
					2	21	
					1	22	
7 trees:					108 trees:		
Total cubic feet			402		Total cubic feet		6,863
Total feet B. M			1,690		Total feet B. M		28,800

Total yield: Pine, 30,490 feet B. M., of which White Pine 5 per cent.
Average annual accretion: Pine, 42 cubic feet.
179 feet B. M.

(6) SITE *g*: — Crawford County. — Sample area: 1 acre.

[About 1,200 feet above sea level.]

Soil: Brown, loamy sand, deep, fresh, moderately loose, with surface cover of fern and grass; sand with stones underlies the soil.
Forest conditions: Two-story stand, upper story of White Pine (1 Red Pine of 26 inches in diameter), with 0.3 density of crown cover, lower story of Fir (22 from 4 to 10 inches in diameter), Beech (4 from 4 to 10 inches in diameter), and Hemlock (19 from 4 to 10 inches in diameter); undergrowth moderately dense, of Maple, Fir, Hemlock, and Beech. Percentages: White Pine, 50; Hemlock, 20; Fir, 25; hardwoods, 5.

Age of pine: 250 to 260 years
Density of crown cover: 0.7.
Number of trees: (*b*).

Classification:

	White Pine.
Dominant ..... per cent ..	77
Oppressed ..... do	13
Suppressed ..... do	10

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
3	16	100 to 120	213	
1	18		79	
2	21		228	
1	23		134	
1	24		146	
3	25		471	
2	26	130 to 150	432	
1	27		464	
7	28		1,743	
2	29		532	
5	30		1,400	
2	31		604	
5	32		1,600	
3	33		1,020	
1	35		381	
1	36		401	
1	42		537	
44 trees:				
Total cubic feet			10,385	
Total feet B. M			62,300	

Average annual accretion: White Pine, 40 cubic feet.
240 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A. MICHIGAN—Continued

MEASUREMENTS OF SAMPLE TREES.

Age class: 130 to 150 years.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
32	133	15.2	92	8.3	48.59	0.43	0.43	2.2	1.07	0.36
37	141	15.5	92	6.2	55.32	.46	.42	2.3	1.27	.39
12	132	16.3	88	7.5	61.70	.47	.66	.8	.49	.46
40	145	18.6	100	7.0	71.11	.58	.44	2.0	1.42	.49
25	128	20.5	98	7.0	94.56	.42	.47	1.5	1.42	.73
27	152	19.0	104	7.3	84.97	.41	.38	1.4	1.19	.55
9	131	22.5	112	5.4	129.42	.41	.46	.7	.91	.98
26	118	23.0	116	6.8	137.91	.41	.46	1.9	2.62	.93
31	153	23.0	100	5.9	137.63	.47	.30	1.7	2.40	.90
11	146	24.6	115	5.2	154.12	.41	.40	1.4	2.16	1.13
Average	140	19.8	102	6.9	97.5	.43	.43	1.6	1.49	.69

OPPRESSED GROWTH.

18	109	14	82	7.5	40.53	0.46	0.56	4.5	1.82	0.37

Age class: 220 to 240 years.

DOMINANT GROWTH.

41	245	20.0	120	11.0	112.56	0.43	0.46	0.9	1.01	0.46
8	242	24.5	137	9.9	191.07	.42	.41	.5	.95	.79
30	226	27.5	138	7.6	215.28	.38	.....	.4	.86	.95
1	226	27.5	129	7.6	222.20	.41	.38	.4	.89	.98
28	220	28.3	143	7.1	264.49	.42	.60	.8	2.11	1.20
31	250	30.2	141	8.7	291.03	.42	.31	.4	1.16	1.16
10	219	33.0	121	6.3	317.85	.44	.43	.7	2.22	1.45
33	226	33.0	140	7.1	321.86	.38	.49	.8	2.57	1.42
39	247	33.0	144	7.2	389.57	.45	.77	.6	2.34	1.64
29	233	37.0	147	6.1	455.05	.41	.55	.6	2.73	1.95
3	245	40.0	125	5.4	479.51	.43	.40	.5	2.40	1.96
Average	233	30.1	135	7.6	296.41	0.41	.48	.6	1.75	1.27
14	258	26.0	119	10.0	162.54	0.37	0.40	0.4	0.65	0.63
7	252	25.2	139	9.5	193.21	.41	.46	.4	.77	.76
38	252	25.5	115	9.5	205.21	.35	.58	.9	1.85	.81
23	265	27.0	126	10.4	207.67	.41	.44	.5	1.05	.78
13	254	30.0	135	8.8	259.13	.39	.45	.4	1.03	1.02
36	256	32.0	142	8.1	267.87	.34	.59	.4	1.07	1.04
4	260	31.5	132	8.3	275.89	.38	.48	.7	1.93	1.06
42	260	29.5	155	8.9	311.99	.42	.48	.3	.93	1.20
16	251	33.0	144	7.1	313.07	.33	.41	.9	2.82	1.24
2	256	31.0	145	7.6	314.06	.41	.39	.5	1.57	1.22
35	265	31.5	144	8.2	314.38	.40	.33	.4	1.25	1.18
6	266	33.0	139	8.0	316.81	.38	.51	.4	1.27	1.19
15	256	32.0	151	7.4	360.75	.41	.33	.7	2.52	1.41
5	258	34.0	138	7.6	370.50	.42	.59	.8	2.96	1.43
17	260	36.0	149	7.5	404.18	.37	.45	.2	.81	1.55
Average	258	30.5	138	8.5	285.15	.39	.45	.5	1.50	1.10

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

(7) SITE *h*: Crawford County.

Soil: Brown, loamy sand, medium fine, light, loose, very deep, fresh, well drained, with surface cover of abundant leaves.
Forest conditions: Moderately dense stand of White Pine intermixed with Hemlock and Beech, with scattering Yellow and White Birch and occasional Red Pine, on a level plain; under growth of young Hemlock and hardwoods.

MEASUREMENTS OF SAMPLE TREES.

Age class: 420 to 450 years.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
5	417	37.0	155	14.0	433.2	0.37	0.45	0.4	1.73	1.03
1	445	35.5	141	10.0	510.5	.52	.39	.6	3.06	1.15
4	455	41.0	152	11.0	583.7	.41	.53	.2	1.17	1.28
9	426	43.0	160	10.5	677.3	.42	.56	.4	2.71	1.59
8	460	46.0	150	(?)	694.1	.40	.48	.3	2.08	1.51
7	457	47.0	160	(?)	721.9	.37	.45	.4	2.89	1.59
3	461	46.0	170	10.0	737.9	.38	.56	.3	2.21	1.60
6	435	46.0	168	(?)	819.6	.42	.51	.4	3.28	1.88
10	458	47.0	162	10.5	855.3	.43	.57	.5	4.28	1.86
Average	446	43.0	157	11.0	670.4	.41	.50	.4	2.60	1.50

Age class: 270 to 290 years.

2	274	45.0	150	7.1	604.3	0.36	0.52	0.4	2.4	2.20

(8) SITE *i*: Crawford County.

Sample area: 1 acre.
Age of pine: 95 to 105 years.
Density of crown cover: 0.6.
Number of trees: 364.

Soil: Brown, loamy sand of medium grain, light, loose, deep, fresh, well drained, with 2 to 3 inches mold on top and surface cover of leaves.
Forest conditions: White Pine (47 per cent) mixed with hardwoods (30 per cent) and Hemlock (23 per cent), on a gentle slope; undergrowth scanty, of young Hemlock and Maple.
Classification:

	White Pine.
Dominant	per cent.. 47
Oppressed	do.... 18
Suppressed	do.... 35

ACRE YIELD.

White Pine.					Hemlock.			Maple.			Beech.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cu. ft.*	*Feet B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
4	3 to 6	90 to 110	.....		18	3 to 6	60 to 80	26	3 to 6	40	20	3 to 6	40 to 50
52	6 to 10		520		44	6 to 10		28	6 to 10		14	6 to 10	
9	10		162		3	10		2	10		1	10	
8	11		256		3	11							
12	12		456		4	12							
15	13		660		2	13							
16	14		800		2	14							
11	15		638		3	16							
11	16		704		1	18							
13	17		936		1	20							
8	18		640		2	23							
5	19		435										
4	20		384										
3	21		309										
1	23		122										
1	25		143										
								White Birch.			Yellow Birch.		
								6	6 to 10	40 to 60	2	6 to 10	
								4	10				
								2	14				
								1	1				
								2	17				
173 trees:					83 trees:			71 trees.			37 trees.		
Total cubic feet			7,165		Total cubic ft.		1,330						
Total feet B. M				28,650	Total feet B. M.		4,780						

Total yield: White Pine and Hemlock, 33,430 feet B. M., of which White Pine 87 per cent.
Average annual accretion: White Pine, 71 cubic feet, 286 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

MEASUREMENTS OF SAMPLE TREES.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
3	100	16.5	98	(*b*)	64.5	0.44	0.45	1.7	1.10	0.64
7	98	16.5	106	(*b*)	68.4	.43	.40	2.2	1.50	.70
6	103	17.0	104	5.3	71.7	.44	.45	1.5	1.07	.70
4	100	19.5	100	4.9	94.6	.45	(*b*)	1.7	1.61	.95
8	103	18.5	109	4.8	95.9	.47	.37	2.1	2.01	.93
Average	101	17.6	103	5.0	79.0	.44	.42	1.8	1.46	.78

CODOMINANT GROWTH.

5	95	14.0	91	6.6	49.6	0.49	0.38	2.0	0.99	0.52
1	101	15.3	91	5.8	52.1	.43	(*b*)	4.2	2.46	.51
2	101	15.5	96	6.0	62.8	.49	.57	2.6	1.63	.62
Average	99	15.0	94	6.1	54.8	.47	.44	2.9	1.69	.55

(9) SITE *j*. Crawford County.

Soil: Gray or light sand, medium fine grain, porous, light, loose, dry (in places fresh), with a moderately leafy surface cover.

Forest conditions: Open stand of mixed White Pine and Norway Pine with scattering White Birch and occasional Oak, Hackmatack, and Banksian Pine on a level plain along the banks of a river; undergrowth scanty, of young Fir, Cedar (*Thuja occidentalis*), and a few small Oaks.

MEASUREMENTS OF SAMPLE TREES.

Age class: 90 to 110 years.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
5	109	13.0	94.0	7.6	45.7	0.52	0.51	3.2	1.46	0.42
24	112	14.0	96.0	7.3	50.2	.47	.47	3.5	1.75	.44
22	109	14.8	93.0	6.7	51.4	.45	.47	2.2	1.14	.47
15	106	15.3	85.0	6.5	53.3	.47	.37	2.5	1.33	.50
7	110	16.5	104.0	6.5	61.3	.41	.30	2.2	1.41	.58
6	109	17.0	101.0	6.3	67.6	.42	.59	1.8	1.22	.62
20	112	17.0	100.0	6.1	72.4	.45	(*b*)	3.4	2.46	.65
4	112	18.3	103.0	5.8	85.3	.44	.56	2.5	2.13	.76
19	108	20.5	105.0	4.8	99.1	.41	.49	1.9	1.88	.91
21	109	20.8	105.0	5.0	99.8	.39	.42	1.6	1.60	.91
Average	109.6	16.7	98.6	6.3	68.9	.44	.46	2.5	1.61	.63

CODOMINANT GROWTH.

1	100	13.5	94.0	7.0	41.0	0.44	0.57	2.0	0.82	0.41
25	96	14.4	90.0	6.6	48.7	.47	(*b*)	4.3	2.08	.50
18	82	16.5	94.0	4.8	65.7	.47	.53	4.0	2.63	.80
9	99	20.0	100.0	4.4	90.9	.41	.46	3.3	3.00	.91
Average	94	16.1	94.5	5.7	61.6	.45	.52	3.4	2.13	.65

Age class 150 to 160 years

DOMINANT GROWTH.

2	158	22.5	114.0	6.6	124.9	0.40	0.36	2.4	3.00	0.80
13	157	21.8	115.0	7.0	121.1	.40	.58	1.2	1.45	.80
Average	157.5	22.1	114.5	6.8	123.0	.40	.47	1.8	2.22	.80

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

(10) SITE *k*: Roscommon County. Sample area: 1 acre.

[About 1,000 feet above sea level.]

Half acre No. 1.

Soil: Brown, loamy sand, deep, fine (for sand), porous, loose, fresh, and well drained (water stands in low ground), with a moderately leafy surface cover; subsoil, same as soil.
Forest conditions: Two story stand on a gentle slope, upper story of White Pine (80 per cent) and Red Pine (20 per cent), lower story of fine tall Hemlock; undergrowth scanty, of young Hemlock, Beech, and dwarf Maple.

Age of pine: 230 to 240 years.
Density of crown cover: 0.8 to 0.9.
Number of trees: 186.

Classification:	White Pine.
Dominant	per cent 63
Oppressed	do.... 21
Suppressed	do.... 16

HALF-ACRE YIELD.

White Pine.					Red Pine.			Hemlock.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cu. feet.*	*Feet B.M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
6	11	80 to 125	192		2	14	80 to 150	32	6 to 10	60
2	15		116		2	16		4	10	70 to 80
2	16		128		4	18		6	11	
4	17		288		14	19		2	12	
2	18		160		6	21		6	14	
6	19		528		2	23		8	15	
2	20		250		2	24		2	17	
4	21		540		2	25		2	18	
8	22		1,216					4	19	100 to 120
12	24	130 to 150	2,076					2	20	
8	25		1,544					2	21	
6	27		1,344					2	22	
8	28		1,920					2	23	
2	30		540					2	24	
4	33		1,312							
76 trees: Total cubic feet			12,174		34 trees: Total cubic feet.		4,250	76 trees: Total cubic feet.		3,616
Total feet B.M			58,400		Total feet B.M		20,500	Total feet B.M		13,000

Total yield: All species 20,060 cubic feet, of which White Pine was 61 per cent.
Average annual accretion: White Pine, 52 cubic feet.
248 feet B.M.

MEASUREMENTS OF SAMPLE TREES.

Age class: 230 to 250 years.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. feet.*			*Per cent.*	*Cu. feet.*	*Cu. feet.*
3	234	23.2	137	10.0	169.0	0.43	0.39	0.8	1.35	0.72
2	236	23.8	142	9.6	197.3	.44	.43	.7	1.38	.83
11	235	24.5	142	9.2	199.1	.43	.43	.7	1.39	.84
1	237	23.5	140	9.6	202.6	.46	.36	.8	1.62	.86
6	237	24.5	145	9.0	205.4	.43	.40	.5	1.03	.86
17	232	24.7	145	(?)	207.0	.43	.47	1.0	2.07	.89
10	233	25.5	143	8.4	212.6	.42	.42	.5	1.06	.91
16	237	25.5	145	9.1	227.3	.44	.44	.9	2.04	.96
15	235	26.0	143	9.0	231.1	.43	.23	.7	1.62	.98
18	245	30.0	122	(?)	233.9	.39	.35	.8	1.87	.95
9	236	26.2	145	9.0	240.2	.44	.42	.3	0.72	1.01
4	236	27.0	150	8.5	271.5	.45	.41	.8	2.17	1.15
8	238	29.0	140	7.8	281.1	.43	.40	.6	1.69	1.18
19	244	34.0	130	7.0	348.1	.42	.62	.5	1.74	1.42
12	233	32.0	144	7.0	349.6	.43	.39	1.0	3.50	1.50
20	251	27.0	120	9.1	206.8	.43	.36	.5	1.03	.82
Average	237	26.6	140	8.7	236.4	.43	.41	.7	1.64	.99

OPPRESSED GROWTH

14	237	21	136	11.0	133.8	0.41	0.51	0.7	0.94	0.56

SUPPRESSED GROWTH.

7	235	13.0	120	17.7	61.1	0.55	0.31	0.6	0.37	0.26
5	229	15.3	126	15.2	86.7	.52	.41	.6	.52	.37
Average	232	14.1	123	16.4	73.9	.53	.36	.6	.45	.31

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

Half acre No. 2.

Soil: Moist, low ground, near swamp.
Forest conditions: White Pine (51 per cent) and Hemlock (49 per cent)
Classification

	White Pine.
Dominant	80 per cent.
Oppressed	10 do.
Suppressed	10 do.

Age of pine: 230 to 240 years.
Density of crown cover: 0.5
Number of trees: 118.

HALF-ACRE YIELD.

White Pine.					Hemlock.		
			Volume.				
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cu. feet.*	*Feet B.M.*		*Inches.*	*Feet.*
2	15	80 to 125	116		6	6 to 10	60
1	18		320		6	11	70 to 80
2	19		176		4	12	
2	22		304		4	13	
2	24		360		4	14	
2	25		400		6	15	100 to 120
4	26		864		6	16	
2	28		498		6	17	
4	29		1,064		2	19	
6	30	130 to 150	1,680		10	20	
2	31		604		2	24	
4	32		1,280		2	25	
12	33		4,080				
2	34		720				
2	35		762				
4	36		1,604				
2	37		846				
2	38		890				
60 trees:					58 trees:		
Total cubic feet			16,586		Total cubic feet		4,490
Total feet B. M			99,400		Total feet B. M.		16,160

Total yield. White Pine and Hemlock 21,076 cubic feet, of which White Pine 71 per cent.
Average annual accretion: White Pine, 70 cubic feet.
423 feet B. M

(11) SITE *l*: Roscommon County. Sample area: 1 acre.

Soil: Light-brown, dry sand, loose, light, very deep, well drained (?), with 1 inch mold on top and surface cover of leaves
Forest conditions: Red Pine (84 per cent) intermixed with White Pine (16 per cent), with occasional Beech on a gentle slope (angle 5°); no undergrowth.
Classification:

	White Pine.	Red Pine.
Dominant	57 per cent.	62
Oppressed	24 do.	31
Suppressed	19 do.	7

Age of pine: (?)
Density of crown cover: (?)
Number of trees: 136.

ACRE YIELD.

White Pine.					Red Pine.			Beech.		
			Volume.							
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
2	10	100 to 120	36		1	6 to 10	90 to 100	1	3 to 6	40
1	11		32		2	10		1	6 to 10	
1	12		38		3	11				
2	13		96		7	12				
1	14		55		13	13				
2	15		126		26	14				
2	16		142		16	15				
3	18		261		18	16				
1	19		96		16	17				
2	21		228		5	18				
2	22		246		5	19				
1	23		134		1	20				
1	27		199							
21 trees:					113 trees:			2 trees.		
Total cubic feet			1,689		Total cubic feet		6,207			
Total feet B. M			7,090		Total feet B. M.		26,060			

Total yield Pine 7,896 cubic feet, of which White Pine 21 per cent

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

(12) SITE *m*: Roscommon County. Sample area: 4 acres.

[900 to 1,000 feet above sea level.]

Acre No. 1.

Soil: Dry, light-brown sand, medium fine, deep, well drained, with moderately leafy surface cover. Age of pine: 160 to 200 years.
Forest conditions: Red Pine (53 per cent) with White Pine (39 per cent) and hardwoods (8 per cent) on uneven ground; stand open, and open places with Red Oak and Maple. Density of crown cover: (?). Number of trees: 91.

Classification:	White Pine.	Red Pine.
Dominant.....per cent..	73	87
Oppressed.....do....	19	11
Suppressed.....do....	8	2

ACRE YIELD.

White Pine.					Red Pine.			Oak.		
			Volume.							
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
1	14	100 to 120	55		1	13	100 to 120	1	Under 3	40
1	17		79		2	14		3	3 to 6	
1	18		88		1	15				
3	19		288		2	16				
2	20		210		6	17			Maple.	
2	21		228		5	18				
5	22		615		7	19				
2	23		268		8	20		2	3 to 6	40
3	24		438		3	21		2	6 to 10	
2	25		314		7	22				
5	26		845		2	23				
4	27		732		2	24				
2	28		392		1	25				
1	33		267							
1	34		283							
1	39		451							
36 trees: Total cubic feet..... 5,553 Total feet B. M..... 26,600					47 trees: Total cubic feet. 5,360 Total feet B. M. 26,000			8 trees.		

Total yield: Pine, 10,913 cubic feet.
52,600 feet B. M., of which White Pine 50 per cent.
Average annual accretion: Pine, 61 cubic feet.
298 feet B. M.

Acre No. 2.

Soil: Dry, light-brown sand, medium fine, deep, well drained, with moderately leafy surface cover. Age of pine: 160 to 200 years.
Forest conditions: Red Pine (75 per cent) with White Pine (25 per cent) intermixed; level. Density of crown cover: (?). Number of trees: 153.

Classification:	White Pine.	Red Pine.
Dominant.....per cent..	62	74
Oppressed.....do....	25	23
Suppressed.....do....	13	3

ACRE YIELD.

White Pine.					Red Pine.		
			Volume.				
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
2	6 to 10	100 to 120			.....	6 to 10	100 to 120
1	11				3	10	
1	12				9	12	
4	14				12	13	
1	15				8	14	
7	16				32	15	
4	17				17	16	
3	18				18	17	
3	19				8	18	
1	20				4	19	
6	21				2	20	
2	22						
3	23						
1	25						
39 trees: Total cubic feet..... 3,332 Total feet B. M..... 15,980					113 trees: Total cubic feet. 7,914 Total feet B. M. 33,240		

Total yield: Pine, 11,246 cubic feet.
49,220 feet B. M., of which White Pine 32 per cent.
Average annual accretion: Pine, 95 cubic feet.
273 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

Acre No. 3.

Soil: Light brown, dry sand, medium fine, deep, well drained, with a moderately leafy surface cover.
Forest conditions: Red Pine (80 per cent) intermixed with White Pine (10 per cent); level.
Classification:

	White Pine.	Red Pine.
Dominant ..... per cent	75	80
Oppressed ..... do....	17	12
Suppressed ..... do....	8	8

Age of pine: 150 to 200 years.
Density of crown cover: (1)
Number of trees: 117.

ACRE YIELD.

White Pine.					Red Pine.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
1	6 to 10	100 to 120	10		5	6 to 10	100 to 120
1	13		48		1	10	
2	14		110		1	11	
1	19		96		6	12	
1	20		105		3	13	
3	22		369		12	14	
2	25		314		10	15	
1	26		169		15	16	
					25	17	
					12	18	
					1	19	
					6	20	
					2	21	
					2	22	
					1	23	
12 trees:					105 trees:		
Total cubic feet			1,221		Total cubic feet		8,170
Total feet B. M				5,120	Total feet B. M		34,300

Total yield: Pine, 9,391 cubic feet.
39,420 feet B. M., of which White Pine 15 per cent.
Average annual accretion: Pine, 52 cubic feet.
219 feet B. M.

Acre No. 4.

Soil: Light-brown, fresh, loose sand, medium fine, deep, well drained, with a moderately leafy surface cover.
Forest conditions: Red Pine (61 per cent) intermixed with White Pine (33 per cent) and hardwoods (6 per cent); scattered young Oak and Beech on uneven ground.
Classification:

	White Pine.	Red Pine.
Dominant ..... per cent..	47	72
Oppressed ..... do....	14	15
Suppressed ..... do....	39	3

Age of pine: 160 to 200 years.
Density of crown cover: (1).
Number of trees: (1).

ACRE YIELD.

White Pine.					Red Pine.			Oak.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Ft. B.M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
6	6 to 10	100 to 120	63		1	11	100 to 120	1	3 to 6	40
3	10		54		2	12				
3	11		96		2	13				
1	12		38		6	14				
2	13		96		14	15				
2	14		110		11	16				
4	15		252		8	17				
3	16		213		13	18			Beech.	
4	18		352		12	19				
2	19		192		12	20				
2	20		210		2	21				
4	22		492		2	22		3	3 to 6	40 to 60
2	23		268					3	6 to 10	
1	25		157					1	13	
3	26		507					1	14	
1	27		183							
1	34		283							
44 trees:					85 trees			9 trees		
Total cubic feet			3,563		Total cubic ft		7,572			
Total feet B. M				14,960	Total ft. B. M.		31,800			

Total yield: Pine, 11,135 cubic feet.
46,760 feet B. M., of which White Pine 32 per cent.
Average annual accretion: Pine, 62 cubic feet.
259 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

MEASUREMENTS OF SAMPLE TREES.

Age class: 160 to 180 years.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
9	178	24.2	118	7.5	170.1	0.46	0.54	1.2	2.04	0.95
29	173	27.2	121	6.2	218.8	.45	.28	.7	1.53	1.26
24	163	26.5	120	6.2	211.0	.46	.31	.7	1.47	1.29
Average...	171	26.0	120	6.6	200.0	.46	.38	.9	1.68	1.17
34	182	25.2	118	7.4	173.0	.43	.53	1.3	2.25	.95
18	188	26.7	118	6.9	202.1	.45	.59	1.2	2.42	1.07
5	186	31.0	119	5.5	286.6	.45	.40	.7	2.0	1.54
Average...	185	27.6	118	6.6	220.5	.44	.51	1.1	2.22	1.19

CODOMINANT GROWTH.

15	179	19.0	125.0	9.9	118.4	0.48	0.26	0.8	0.95	0.66
7	185	17.0	125.0	11.5	79.2	.41	.51	1.5	1.19	.42
10	185	20.3	105.0	9.1	111.8	.46	.32	.8	.89	.60
6	184	24.5	109.0	7.4	128.6	.36	.38	1.0	1.29	.70
33	182	22.0	111.0	7.7	134.3	.45	.44	1.5	2.01	.73
Average...	184	20.9	112.5	8.9	113.5	.42	.41	1.2	1.34	.61

OPPRESSED GROWTH.

36	165	18	103	8.7	87.9	0.47	0.46	1.2	1.05	0.53

Age class: Over 200 years.

DOMINANT GROWTH.

19	211	28.5	119	7.3	218.9	0.41	0.63	1.3	2.84	1.03

OPPRESSED GROWTH.

13	206	22	119	9.7	144.4	0.46	0.38	0.6	0.87	0.70

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

A.—MICHIGAN—Continued.

(13) SITE *n*. Roscommon County. Sample area: 1 acre.

[900 to 1,000 feet above sea level.]

Soil. Light brown, loamy sand, fresh, light, loose, fine, well drained, with 2 to 3 inches mold on top, and a surface cover of abundant leaves.

Forest conditions: Hardwoods (69 per cent) mixed with White Pine (31 per cent) situated on a slope (angle 10°); undergrowth scanty, of young Oak and Beech. [The single Red Pine standing rather exceptional. About 20 to 25 per cent of Red Pine would have been more typical.]

Classification:

	White Pine.
Dominant	per cent.. 80
Oppressed	do.... 10
Suppressed	do.... 10

Age of pine: 160 to 200 years.
Density of crown cover: (?)
Number of trees: 130.

ACRE YIELD.

White Pine.					Beech.			Rock Maple.		
			Volume.							
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic ft.*	*Feet B.M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
1	11		32		26	3 to 6		6	6 to 10	
3	13		159		34	6 to 10		1	10	
1	14		60		4	11		1	12	
1	15		72		6	12		1	13	
1	17		90		1	13		1	14	
2	20		240		1	14		1	17	
3	21		387		1	15				
3	23		477		1	16				
1	24	100	166		1	18				
3	25	to	555							
3	26	130	600							
4	27		864							
4	28		924							
1	29		247							
2	31		560							
2	32		594							
2	33		630							
2	34		668							
1	36		373							
								Red Oak.		
								1	6 to 10	
								1	12	
								1	13	
								1	26	
40 trees:					75 trees.			15 trees.		
Total cubic feet			7,698							
Total feet B. M			36,950							

Average annual accretion: White Pine, 42 cubic feet.
205 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B.—WISCONSIN:

(1) SITE *a*: Washburn County. Sample area, 2 acres.

[1,200 feet above sea level.]

Acre No. 1.

Soil: Fresh clay, underlaid by hardpan of clay and stones; 4 inches of mold, surface cover leafy. Age of pine, 200 to 220 years.
Forest conditions: Two story stand, White Pine occupying upper story, hardwoods (Maple, Yellow Birch, Elm or Basswoods, or Hornbeam) the lower story; undergrowth dense, of young hardwoods, 1 to 3 inches in diameter, 20 to 30 feet high. White Pine, 56 per cent; hardwoods, 44 per cent. Density of crown cover: (1). Number of trees: 76.

Classification:

	White Pine.
Dominant	73 per cent.
Oppressed	9 do.
Suppressed	18 do.

ACRE YIELD.

White Pine.					Maple.		
			Volume.				
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B.M.*		*Inches.*	*Feet.*
2	11	80 to 120	64		1	3 to 6	40
3	14		165		18	6 to 10	60
1	16		71		3	10 to 14	80
1	17		79				
1	18		88				
1	19		96				
1	20		105				
1	21		114				
3	22	120 to 135	420				
3	24		480				
2	26		384				
3	27		621				
4	28		924				
1	29		247				
4	30		1,040				
1	31		280				
3	32		891				
4	33		1,260				
2	34		694				
1	35		367				
1	38		429				

Elm.

2	6 to 10	60

Yellow Birch.

1	6 to 10	60
4	10 to 14	80
4	14 to 18	

43 trees:
Total cubic feet 8,119
Total feet B. M 52,920

33 trees:

Average annual accretion: White Pine, 38 cubic feet.
252 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B.—WISCONSIN—Continued.

Acre No. 2.

Soil: Fresh clay, underlaid by hardpan of clay and stones; 4 inches of mold, surface cover leafy.

Forest conditions: Two-story stand, White Pine occupying the upper story and hardwoods (Maple, Yellow Birch, Elm or Basswood, or Hornbeam) the lower story; undergrowth scanty, of young hardwoods and Fir. White Pine, 52 per cent, hardwoods, 48 per cent.

Classification:

	White Pine.
Dominant ..... per cent.	75
Oppressed ..... do....	22
Suppressed ..... do ...	3

Age of pine: 200 to 220 years.
Density of crown cover: (*b*)

Number of trees: 132.

ACRE YIELD.

White Pine.					Fir.		
			Volume.				
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
1	14	80 to 120	55		5	3 to 6	40
1	16		71				
3	19		288				
2	20		210			Elm.	
1	21		114				
2	22		280				
6	23		918				
9	24		1,440		1	3 to 6	40
3	25		534				
6	26		1,152			Hornbeam.	
5	27		1,035				
5	28		1,155				
6	29		1,482				
3	30	120 to 140	780		5	3 to 6	10
2	31		560		1	6 to 10	60
1	33		315				
1	34		347			Yellow Birch.	
3	35		1,101				
3	36		1,161				
1	37		408				
1	38		429				
1	39		485		12	3 to 10	40
3	40		1,521		16	6 to 10	60
					2	10 to 14	80
					3	14 to 18	80
					1	19	86
						Butternut.	
					1	3 to 6	40
					1	6 to 10	60
						Basswood.	
					9	3 to 6	40
					6	6 to 10	60
69 trees:					63 trees.		
Total cubic feet 15,849							
Total feet B. M 95,040							

Average annual accretion: White Pine, 75 cubic feet.
452 feet B. M.

MEASUREMENTS OF SAMPLE TREES.

Tree number.	Age.	Diameter (breast high).	Height.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Average annual accretion.
	Years.	*Inches.*	*Feet.*	*Cu. ft.*			*Cu. ft.*
1	204	24.7	102.0	166	0.49	0.45	0.81
2	221	27.0	113.0	183	.41	.37	.82
3	213	27.0	121.5	191	.40	.53	.90
4	214	26.0	126.0	201	.43	.52	.94
5	216	26.8	126.0	210	.42	.46	.97
6	202	24.0	134.0	187	.41	.40	.93
7	204	29.0	152.0	238	.39	.39	1.17
8	212	29.0	133.0	250	.41	.42	1.18
9	213	30.0	133.5	291	.44	.47	1.37
Average	211	27.0	124.0	213	.42	.44	1.01

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B.—WISCONSIN—Continued.

(2) SITE *c*: Washburn County. Sample area: 3 acres.

[1,400 feet above sea level.]

Acre No. 1.

Soil: Light-colored clay, underlaid by sand at a depth of about 2 feet; fresh, moist in hollow, with 3 inches mold on top and surface cover of leaves.

Forest conditions Two-story stand of typical open pine growth, upper story of White Pine (22 per cent), lower story of hardwoods (74 per cent), mainly Rock Maple, scattering Yellow Birch, and occasional Elm, Hornbeam, and Fir (4 per cent); undergrowth, moderately dense, of young hardwoods.

Age of pine: 200 to 220 (few 160) years.

Density of crown cover: (*1*)

Number of trees: 88.

ACRE YIELD.

White Pine.					Rock Maple.			Yellow Birch.			Elm.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cu. ft.*	*Ft. B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
2	18	80 to 120	160		18	3 to 6	40	1	3 to 6	40	1	15	80
1	19		87		24	6 to 10	60	3	6 to 10	60			
1	21		103		6	10 to 14	80	2	10 to 14	80	Hornbeam.		
2	23		318		1	17	80	1	15	80			
2	26		400		1	19	80	1	16	80			
1	28		231					1	17	80	3	3 to 6	40
1	32	120 to 140	297					1	20	80			
1	33		315					1	31	Over 80	Fir.		
1	34		334										
2	35		706								4	3 to 6	4
3	38		1,335										
1	40		490										
1	46		638										
19 trees: Total cubic feet ..... 5,414 Total feet B. M 32,480					50 trees.			11 trees.			8 trees.		

Average annual accretion: White Pine, 26 cubic feet.
155 feet B. M.

Acre No. 2.

Soil: Light-colored clay, underlaid by sand at a depth of about 2 feet; fresh, moist in hollow, with 3 inches mold on top and surface cover of leaves.

Forest conditions: Two-story stand of White Pine (44 per cent) mixed with hardwoods (53 per cent), upper story of pine, the lower story of hardwoods (Rock Maple intermixed with Yellow Birch and scattering Hornbeam and Elm) and occasional Fir (3 per cent); no undergrowth.

Age of pine: 200 to 220 (few 160) years.

Density of crown cover: (*1*)

Number of trees: 136

Classification:

	White Pine.
Dominant ..... per cent..	68
Oppressed ..... do....	26
Suppressed ..... do....	6

ACRE YIELD.

White Pine.				Rock Maple.		
Number of trees.	Diameter (breast high).	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
4	6 to 10	40		36	3 to 6	40
4	14	20		16	6 to 10	60
4	18	320		Yellow Birch.		
4	19	348				
4	20	384		12	6 to 10	60
12	24	1,992		4	10 to 14	80
4	26	800		4	14 to 18	
4	29	988		Fir.		
8	31	2,240				
8	32	2,376		4	3 to 6	40
4	45	2,448				
60 trees: Total cubic feet ..... 12,136 Total feet B. M 72,810				76 trees:		

Average annual accretion: White Pine, 58 cubic feet.
347 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B.—WISCONSIN—Continued.

Acre No. 3.

Soil: Light-colored clay, underlaid by sand at a depth of about 2 feet; fresh, moist in hollow, with 3 inches mold on top, and surface cover of leaves.

Forest conditions: Two-story stand of White Pine (40 per cent) mixed with hardwoods (47 per cent), upper story of hardwoods (Rock Maple intermixed with Yellow Birch and scattering Hornbeam and Elm) and occasional Fir (13 per cent); moderately dense undergrowth, of very young hardwoods.

Classification:

	White Pine.
Dominant.....per cent..	76
Oppressed.....do....	8
Suppressed.....do....	16

Age of pine: 200 to 220 (few 180) years.

Density of crown cover: (*b*).

Number of trees: 123.

ACRE YIELD

White Pine.

Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
1	13	80 to 120	41	
1	15		58	
2	17		114	
3	18		240	
1	19		87	
5	20		480	
3	23		477	
3	24		498	
1	25		185	
2	26		400	
3	27		648	
3	28		693	
2	29		494	
2	30		520	
5	31	120 to 140	1,100	
2	33		630	
1	34		334	
1	35		353	
3	36		1,203	
1	37		423	
2	42		1,074	
1	43		562	
1	44		584	
1	46		638	
50 trees:				
Total cubic feet			12,169	
Total feet B. M				73,000

Rock Maple.

Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*
18	3 to 6	40
19	6 to 10	60
6	10 to 14	80
1	14 to 18	80

Yellow Birch.

Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*
1	3 to 6	40
2	6 to 10	60
3	10 to 14	80
1	14	
1	15	
1	18	
1	19	
54 trees.		

Elm.

Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*
1	6 to 10	60
1	14 to 18	80

Basswood.

Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*
1	6 to 10	60

Fir.

Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*
12	3 to 6	40
4	6 to 10	60
19 trees.		

Average annual accretion: White Pine, 58 cubic feet. 348 feet B. M.

MEASUREMENTS OF SAMPLE TREES

Age class: 100 to 150 years.

Tree number.	Age.	Diameter (breast high).	Height.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Average annual accretion.
	Years.	*Inches.*	*Feet.*	*Cu. ft.*			*Cu. ft.*
46	107	18.5	86.0	63	0.39	0.44	0.59
47	104	18.0	80.0	70	.49	.63	.67
48	102	18.7	86.5	74	.45	.61	.73
49	120	19.3	90.0	81	.46	.55	.68
50	101	14.0	75.0	41	.52	.40	.41
Average	107	17.7	83.5	66	.46	.52	.61
25	102	12.8	77.5	34	.49	.30	.34
26	102	13.2	73.5	36	.51	.48	.35
27	100	14.0	75.0	46	.57	.37	.46
28	102	15.7	79.5	56	.52	.58	.55
29	103	22.2	83.0	97	.43	.49	.94
30	112	18.8	86.0	81	.49	.50	.70
31	118	17.0	86.5	69	.50	.41	.59
32	105	5.6	41.5	4	.56	.56	.38
Average	105.5	15.0	75.0	53	.51	.46	.54
1	104	15.3	91.0	52	.45	.....	.50
2	104	15.5	96.0	63	.50	.51	.61
3	101	16.5	98.0	65	.44	.41	.64
4	105	19.5	100.0	95	.45	.....	.90
5	100	14.0	94.0	50	.50	.38	.50
6	105	17.0	104.0	72	.44	.45	.69
7	102	16.5	106.0	68	.43	.41	.67
8	105	18.5	109.0	96	.47	.38	.91
Average	103	16.6	100.0	70	.46	.42	.68
1	137	24.0	105.0	118	.36	.31	.86
2	142	27.8	108.0	201	.44	.43	1.42
Average	139.5	26.0	106.5	159	.40	.37	1.14

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued

B.—WISCONSIN—Continued.

MEASUREMENTS OF SAMPLE TREES—Continued.

Age class: 150 to 200 years.

Tree number.	Age.	Diameter (breast high).	Height.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Average annual accretion.
	Years.	*Inches.*	*Feet.*	*Cu. ft.*			*Cu. ft.*
13	207	19.0	94.5	94	0.50	0.45	0.45
14	200	20.3	101.0	100	.44	.55	.50
15	208	22.6	96.0	121	.45	.40	.58
16	195	24.2	97.0	133	.43	.32	.68
17	197	24.2	112.5	146	.41	.54	.74
18	196	23.0	116.0	154	.46	.46	.79
19	205	23.5	113.5	161	.47	.42	.78
20	198	25.8	106.5	166	.43	.42	.84
21	217	29.5	114.5	192	.35	.58	.88
22	197	29.0	115.0	236	.45	.63	1.20
23	210	31.0	115.0	253	.42	.59	1.20
24	202	30.5	127.5	282	.44	.47	1.40
25	205	33.3	120.0	304	.42	.43	1.48
26	205	25.6	100.5	161	.44	.39	.78
27	204	25.3	116.5	175	.43	.51	.86
28	225	28.2	110.0	175	.37	.50	.78
29	206	28.5	103.0	183	.40	.43	.89
30	207	28.5	119.0	213	.40	.34	1.03
31	204	32.0	111.5	274	.44	.54	1.34
32	205	32.0	115.0	281	.44	.69	1.37
33	200	34.0	117.0	285	.39	.43	1.43
34	201	28.3	119.0	208	.40	.61	1.03
Average	204	27.0	111.0	195	.47	.49	1.75
40	195	16.0	108.0	75	.47	.44	.38
35	201	22.2	95.0	115	0.45	0.63	0.57
36	191	29.0	116.0	216	.41	.55	1.13
37	216	28.5	120.0	262	.49	.52	1.21
38	220	34.5	128.0	308	.37	.56	1.40
39	207	35.0	126.0	342	.41	.39	1.65
Average	207	29.8	117.0	249	.43	.53	1.19
1	204	34.0	118.0	274	.37	.51	1.34
2	209	35.5	121.0	305	.37	.55	1.46
3	200	35.0	116.0	306	.40	.41	1.53
4	212	34.0	120.0	313	.42	.42	1.48
5	210	33.5	141.0	323	.37	.50	1.54
6	212	37.0	128.0	355	.37	.64	1.68
7	214	38.0	114.0	357	.40	.47	1.67
8	206	38.0	127.0	371	.37	.46	1.80
9	220	37.0	127.0	399	.42	.61	1.81
10	210	42.0	140.0	506	.38	.60	2.41
11	210	43.0	144.0	577	.40	.56	2.75
12	210	50.0	138.0	726	.39	.51	3.46
Average	210	38.0	128.0	401	.39	.52	1.91
41	166	25.0	105.0	158	.44	.38	.95
42	151	29.5	103.0	175	.36	.52	1.16
43	167	28.7	96.0	176	.41	.55	1.05
44	155	29.0	101.5	201	.43	.52	1.30
45	155	28.0	113.5	217	.45	.41	1.40
Average	159	28.0	104.0	185	.42	.47	1.17

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B.—WISCONSIN—Continued.

(3) SITE *c*. Barron County. Sample area: 3 acres.

Acre No. 1.

Soil: Clayey loam mixed with sand and stones, leaf cover underlaid by 2 to 3 inches mold; subsoil, clay in places and in others sand. Age of pine: 160 to 200 (few 90 to 100) years.

Forest conditions: Ridges covered with White Pine (65 per cent) intermixed with hardwoods (32 per cent), mainly Rock Maple, few Yellow Birch, Hornbeam, Basswood, and occasional Elm, with scattering Fir (2 per cent) and Red Pine (1 per cent); hollows sometimes full of water, but more often open, grassy swamps, with Alder and Hackmatack, fringed by pine. Density of crown cover: (*a*).

Number of trees: 166.

Classification:

	White Pine.
Dominant	per cent.. 57
Oppressed	do.... 30
Suppressed	do.... 13

ACRE YIELD.

White Pine.					Red Pine.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B.M.*	2	*Inches.* 18	*Feet.* 100
4	6 to 10		40				
4	11		112				
6	12		204			Maple.	
2	13		78				
6	14	80	270				
10	15	to	520				
8	16	100	464		20	3 to 6	40
2	17		130		18	6 to 10	60
6	18		432				
4	19		316				
8	20		688			Yellow Birch.	
2	21		248				
4	22		536				
4	23		584				
6	24		918		4	3 to 6	40
8	25	110	1,368				
6	26	to	1,110			Hornbeam.	
4	27	130	796				
2	28		426				
8	30		1,920		6	3 to 6	40
4	32		548				
2	33		582				
						Basswood.	
					4	3 to 6	40
						Fir.	
					4	3 to 6	40
108 trees:					58 trees.		
Total cubic feet			12,290				
Total feet B. M				58,990			

Average annual accretion: White Pine, 65 cubic feet.
310 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued

B.—WISCONSIN—Continued.

Acre No. 2.

Soil: Clayey loam mixed with sand and stones, leaf cover underlaid by 2 to 3 inches mold; subsoil, clay in places and in others sand.

Forest conditions: Ridges covered with White Pine (49 per cent) intermixed with hardwoods (51 per cent), mainly Rock Maple, few Yellow Birch, Hornbeam, Basswood, and occasional Elm, with scattering Fir and Red Pine; hollows sometimes full of water, but more often open, grassy swamps, with Alder and Hackmatack, fringed by pine.

Age of pine: 160 to 200 (few 90 to 100) years.

Density of crown cover: (?).

Number of trees: 110.

Classification:

	White Pine.
Dominant	per cent.. 78
Oppressed	do.... 22
Suppressed	do.... 0

ACRE YIELD.

White Pine.					Maple.		
			Volume.				
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
2	6 to 10	80	20		26	3 to 6	40
2	19	to	158		16	6 to 10	60
2	20	100	172		2	10 to 14	80
4	21		496				
4	22		536		Yellow Birch.		
2	23		292				
10	24		1,530				
2	26		370		2	23	80
10	27	110	1,990				
2	28	to	426		Hornbeam.		
2	29	130	456				
6	30		480				
2	32		548				
2	35		652		10	3 to 6	40
2	42		1,074				
54 trees:					56 trees.		
Total cubic feet			9,200				
Total feet B. M			41,160				

Average annual accretion: White Pine, 48 cubic feet.
216 feet B. M

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B. WISCONSIN—Continued.

Acre No. 5.

Soil: Clayey loam mixed with sand and stones, leaf cover underlaid by 2 to 3 inches mold; subsoil, clay in places and in others sand.

Forest conditions: Ridges covered with White Pine (59 per cent) intermixed with hardwoods (38 per cent), mainly Rock Maple, few Yellow Birch, Hornbeam, Basswood, and occasional Elm, with scattering Fir (3 per cent) and Red Pine; hollows sometimes full of water, but more often open, grassy swamps, with Alder and Hackmatack, fringed by pine.

Age of pine: 160 to 220 (few 90 to 100) years.

Density of crown cover: (?).

Number of trees: 144.

Classification:

	White Pine.
Dominant	per cent... 61
Oppressed	do.... 15
Suppressed	do... 24

ACRE YIELD.

White Pine.					Maple.		
Number of trees.	Diameter (breast high).	Height.	Volume.		Number of trees.	Diameter (breast high).	Height.
			Bole.	Merchantable timber.			
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*
3	6 to 10		30		22	3 to 6	40
1	11		28		11	6 to 10	60
1	13		39				
5	14	80	225				
1	15	to	52			Hornbeam.	
11	17	100	715				
5	18		360				
7	19		553				
6	20		516		3	3 to 6	40
4	21		496				
4	22		536				
6	23		876			Basswood.	
4	24		612				
5	25		855				
3	26	110	555				
1	27	to	199		4	3 to 6	40
4	28	130	852		2	6 to 10	60
1	29		228				
5	30		1,200				
2	31		518			Fir.	
1	32		274				
1	34		360				
1	35		380				
1	36	140	401		5	3 to 6	40
1	38		445				
1	40		490				
85 trees:					49 trees.		
Total cubic feet			11,795				
Total feet B. M			56,610				

Average annual accretion: White Pine, 62 cubic feet.
298 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B.—WISCONSIN—Continued.

MEASUREMENTS OF SAMPLE TREES.

Age class: 200 to 220 years.

Tree number.	Age.	Diameter (breast-high).	Height.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Average annual accretion.
	Years.	*Inches.*	*Feet.*	*Cu. ft.*			*Cu. ft.*
1	204	27.3	123.0	219	0.44	0.59	1.07
2	210	25.2	137.0	227	.48	.40	1.08
3	207	31.0	127.5	246	.37	.35	1.19
4	200	29.5	116.0	239	.43	.51	1.20
5	206	29.2	130.5	282	.46	.29	1.37
6	205	30.0	133.0	284	.43	.52	1.38
7	210	34.0	118.5	292	.39	.37	1.40
8	214	36.0	113.5	312	.39	.38	1.46
9	210	39.0	130.0	415	.38	.49	1.98
Average...	207	31.0	125.0	280	.42	.43	1.35
10	211	20.2	116.0	132	.51	.64	.63
11	228	23.6	113.0	148	.43	.42	.65
12	220	22.8	121.0	153	.45	.45	.70
13	207	27.2	107.5	200	.46	.28	.97
14	204	27.0	121.0	204	.42	.43	1.00
15	205	27.0	122.0	210	.43	.25	1.02
16	212	27.8	104.5	180	.41	.51	.85
17	204	27.3	112.0	186	.41	.41	.91
Average...	211	25.0	114.0	177	.44	.42	.84

Age class: 160 to 180 years.

18	168	30.0	121.5	206	0.35	0.49	1.22
19	165	28.4	120.0	224	.41	.50	1.36
20	173	28.4	127.0	257	.46	.35	1.49
21	163	17.8	91.5	72	.46	.34	.44
22	162	23.0	101.0	130	.46	.54	.80
23	174	28.0	108.5	167	.36	.54	.96
24	166	25.4	104.0	166	.45	.52	1.00
Average...	167	26.0	110.0	174	.42	.47	1.04

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B.—WISCONSIN—Continued.

(D) SITE *f*: Washburn County.

Soil: Light brown sandy loam, medium fine grain, loose, deep, fresh, well drained, with abundant leafy surface cover.

Forest conditions. An open stand of hardwoods (Rock Maple, Yellow Birch and scattering Basswood, with Hemlock, and occasional Red Oak, White Birch, and Poplar), in which White Pine is scattered in varying proportions, on broken land, with frequent swamps in the hollows; undergrowth of young hardwoods, Fir and Hornbeam, and few Hemlock.

MEASUREMENTS OF SAMPLE TREES.

Age class: 80 to 100 years.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cubic feet.*			*Per cent.*	*Cubic feet.*	*Cubic feet.*
51	54	5.5	37	.....	3.2	0.52	0.57	.....	.....	.06
52	62	6.0	40	.....	4.2	.53	.50	.....	.....	.07
53	68	6.8	46	.....	5.5	.48	.72	.....	.....	.08
54	90	6.8	38	.....	4.8	.50	.45	.....	.....	.05
Average...	68.5	6.3	40	.....	4.4	.51	.56	.....	.....	.06
DOMINANT GROWTH.										
22	82	14.0	82	5.5	43.0	0.49	0.39	4.0	1.72	0.52
23	81	14.7	84	5.0	48.0	.50	.42	2.7	1.30	.60
31	83	15.0	82	4.6	48.1	.48	.41	5.2	2.50	.58
27	79	15.0	83	4.8	50.8	.48	.31	3.2	1.62	.64
30	81	19.0	85	3.9	78.2	.46	.37	2.4	1.88	.96
33	89	18.7	96	3.9	85.7	.47	.51	4.6	3.94	.96
Average...	82.5	16.0	85	4.6	59.0	.48	.40	3.7	2.16	.71
OPPRESSED GROWTH.										
26	82	11.3	101	6.6	30.0	0.42	0.40	3.1	0.93	0.36
32	81	11.8	77	6.2	30.5	.50	.37	4.0	1.22	.37
29	80	11.9	81	5.7	32.8	.51	.33	4.6	1.51	.41
24	92	14.5	79	5.6	39.7	.43	.54	3.6	1.43	.43
Average...	84	12.4	84.5	6.0	33.3	.46	.41	3.8	1.27	.39
SUPPRESSED GROWTH.										
18	127	14	73	6.5	39.7	0.50	0.31	4.3	1.71	0.31

Age class: 120 to 130 years.

DOMINANT GROWTH.

14	121	20.2	91	5.4	90.9	0.45	0.50	3.4	3.09	0.75
28	125	24.5	89	4.0	131.8	.45	.58	2.9	3.82	1.05
15	125	26.5	96	4.0	141.5	.39	.46	1.5	2.12	1.13
16	125	26.3	105	4.1	176.8	.47	.53	1.6	2.83	1.41
17	119	29.0	97	3.8	184.5	.42	.57	1.5	2.77	1.55
Average...	123	25.3	95	4.3	145.1	.44	.53	2.2	2.92	1.18

Age class: 220 to 230 years.

DOMINANT GROWTH.

35	223	30.5	116	7.0	237.4	0.40	0.38	0.8	1.90	1.06
10	223	31.0	112	7.0	246.6	42	.56	.6	1.48	1.10
12	228	35.3	124	6.0	322.2	.40	.48	.5	1.61	1.41
5	219	35.0	118	6.0	359.9	.45	.44	.7	2.52	1.64
Average...	223	33.0	117	6.5	291.5	.42	.46	.6	1.88	1.30

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued

B.—WISCONSIN—Continued.

(5) SITE *g*:

Washburn County.

Sample area 1 acre.

Soil. Loam, generally fresh, sand and stone mixed, 2 to 3 inches mold on top, and a surface cover of leaves.

Forest conditions: Two-story stand, upper story of White Pine (54 per cent) and Red Pine (9 per cent), second story of Fir (13 per cent) and hardwoods (24 per cent)—Maple, with scattering White and Yellow Birch, occasional Oak and Elm, Hemlock occurring singly; undergrowth scanty, of young hardwoods, uneven land full of drift ridges and hollows, often with steep inclines, the hollows frequently full of water.

Age of pine: 160 to 230 years.
Density of crown cover: (*b*)

Number of trees: 143.

Classification:

	White Pine.
Dominant	per cent.. 70
Oppressed	do.... 15
Suppressed	do.... 15

ACRE YIELD.

White Pine.					Red Pine.			Maple.		
Number of trees.	Diameter (breast high).	Height.	Volume.		Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
			Bole.	Merchantable timber.						
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
3	6 to 10	80 to 100	30		1	15	80 to 120	9	3 to 6	40
3	11		84		2	16		16	6 to 10	60
1	12		34		1	17		3	10 to 14	80
3	13		117		2	18				
4	14		180		1	19			Birch.	
5	15		260		3	20				
2	16		116		1	24		2	3 to 6	40
5	17		325		1	25		3	6 to 10	60
2	18		176		1	26		1	14	80
5	19		480					1	16	
5	20		525							
8	21		912						Fir.	
4	22		492							
3	23		402					16	3 to 6	40
3	24	100 to 120	438					2	6 to 10	60
5	25		785							
6	26		1,014							
2	27		364							
3	29		627							
1	31		237							
1	32		251							
1	33		267							
2	34		566							
77 trees:					13 trees:			53 trees.		
Total cubic feet			8,682		Total cubic feet		1,469			
Total feet B. M			41,600		Total feet B. M		6,160			

Average annual accretion: Pine, 51 cubic feet.
239 feet B. M.

MEASUREMENTS OF SAMPLE TREES.

Age class: 220 to 230 years.

Tree number.	Age.	Diameter (breast high).	Height.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Average annual accretion.
	Years.	*Inches.*	*Feet.*	*Cubic feet.*			*Cubic feet.*
10	216	31.8	121.5	287	0.43	0.40	1.33
11	222	35.0	123.5	344	.42	.46	1.55
12	228	24.8	116.5	160	.41	.40	.70
13	220	24.0	100.0	156	.49	.27	.78
14	208	15.0	96.0	58	.50	.47	.28
16	220	24.5	107.5	157	.45	.35	.71
17	218	29.0	118.0	240	.44	.49	1.10
Average	219	26.3	112.0	200	.45	.40	.92

Age class: 160 to 180 years.

3	160	23.5	104.5	127	0.40	0.40	0.79
4	170	24.0	119.0	172	.46	.41	1.01
5	178	24.2	114.0	176	.48	.38	.99
6	170	25.7	111.5	181	.45	.41	1.07
7	175	27.3	122.0	217	.43	.46	1.24
8	168	30.5	114.0	256	.44	.42	1.52
15	185	23.2	110.5	138	.42	.34	.71
9	173	26.0	112.0	190	.46	.28	1.10
Average	172	25.5	113.0	182	.44	.39	1.06

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

B.—WISCONSIN—Continued.

(6) SITE *w* Lincoln County.

Soil: Red, compact clay (black on top), well drained, with leafy surface cover.
Forest conditions: A mixed stand of White Pine (50 per cent), Hemlock (30 per cent), and Birch (20 per cent), rolling country.

MEASUREMENTS OF SAMPLE TREES.

Age class 100 to 150 years.

Tree number.	Diameter (breast high).	Height.	Volume of tree.	Factor of shape.	Tree number.	Diameter (breast high).	Height.	Volume of tree.	Factor of shape.
	Inches.	*Feet.*	*Cu. ft.*			*Inches.*	*Feet.*	*Cu. ft.*	
60	21.0	97	108.1	0.48	25	36.5	114	308.5	.38
5	20.5	97	105.8	.48	Average	28.6	103	199.6	.43
86	36.5	104	276.2	.37					

Age class: 150 to 200 years.

37	24.0	117	122.2	0.33	40	31.0	132	273.2	.40
79	24.0	98	137.7	.44	88	35.0	118	287.7	.36
95	27.0	101	140.5	.35	38	34.0	133	313.8	.37
45	24.0	104	136.7	.42	44	35.0	138	311.4	.34
48	25.0	87	140.1	.47	39	32.0	140	318.6	.41
76	24.0	121	178.6	.47	84	36.0	127	283.2	.35
19	24.0	121	180.7	.47	27	36.0	157	365.8	.33
78	33.0	107	236.8	.37					
94	34.0	105	249.0	.38	Average	30.0	120	231.2	.38
47	33.0	136	257.1	.32					

Age class: 200 to 250 years.

90	25.0	105	102.2	0.29	75	36.0	103	263.5	.36
22	25.0	111	105.2	.28	23	33.5	114	267.8	.38
13	22.0	118	129.9	.42	89	33.5	115	267.8	.38
67	25.0	97	136.6	.41	35	29.0	123	277.3	.48
92	25.0	101	139.4	.40	90	37.0	110	274.4	.33
6	24.0	115	151.7	.42	34	32.0	129	286.2	.40
57	24.0	115	153.5	.42	82	38.0	123	290.5	.30
81	27.0	106	173.5	.41	55	35.0	133	311.0	.35
33	30.0	119	180.4	.31	17	38.0	149	315.7	.27
93	31.0	97	181.5	.36	4	35.0	149	335.6	.34
100	29.0	97	182.7	.41	61	35.0	148	339.8	.34
71	27.0	98	185.6	.48	20	34.0	138	361.5	.41
31	27.0	126	194.2	.39	10	51.5	148	634.8	.30
65	30.0	115	194.6	.34					
58	28.5	127	202.0	.36	Average	31.7	119	235.5	.36
73	35.0	108	208.6	.29					
28	29.0	135	209.7	.34	8	26.0	126	159.1	.34
50	26.0	117	215.4	.50	69	27.0	119	164.6	.35
14	26.0	117	216.6	.50	51	26.0	126	167.0	.36
63	28.5	127	216.8	.38	52	27.0	152	188.3	.31
54	30.0	129	217.2	.34	12	27.0	152	191.3	.32
68	31.0	94	218.8	.44	83	30.0	126	207.9	.34
66	31.0	104	220.7	.42	56	31.0	113	227.1	.38
32	32.0	136	221.1	.29	80	34.0	129	240.6	.30
7	31.0	114	223.5	.37	72	33.0	116	256.9	.37
59	31.0	121	228.4	.36	62	32.0	137	257.0	.34
91	32.0	119	230.8	.35	3	32.0	137	263.0	.34
2	31.0	122	233.1	0.36	85	32.0	108	272.3	.45
87	36.0	110	237.6	.31	21	34.0	137	276.2	.32
24	36.0	119	239.6	.28	18	36.0	126	279.6	.31
30	38.0	137	243.2	.22	26	32.0	138	293.4	.38
1	35.0	128	247.5	.29	9	36.0	135	303.6	.32
16	35.0	128	248.2	.29	29	34.0	134	310.0	.37
97	33.0	105	255.1	.41	70	34.0	134	321.9	.38
93	37.0	101	256.8	.34	41	35.0	129	341.6	.40
74	38.0	119	258.8	.28					
49	38.5	139	260.1	.32	Average	31.5	130	248.6	.35
77	34.0	104	261.4	.40					

Age class: 300 to 350 years.

98	31.0	115	215.9	0.36	15	33.0	136	332.0	0.41
42	30.0	132	219.8	.34	64	36.0	124	237.0	.27
53	30.0	120	231.9	.39	36	34.0	146	380.4	.41
46	36.0	124	240.3	.27					
43	33.0	129	296.2	.39	Average	34.3	129	273.6	.33
11	46.0	140	309.4	.19					

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

C.—PENNSYLVANIA:

(1) SITE *d*: Clinton County. Sample area: 2 acres.

[2,000 feet above sea level.]

Soil: Rocky, underlaid by sand, stone, or slates in places, sand or clay or a mixture of both in varying proportions; no soil to depth of 4 to 5 feet, rocks covered with 3 inches mold, and Rock Fern, Laurel, Green Brier, and in openings some Blackberries are seen.

Forest conditions: Hemlock (60 per cent) intermixed with White Pine (24 per cent), scattering Black Birch and Yellow Birch and occasional Oak, Chestnut, and Maple, on steep slopes bordering Hyner Run; undergrowth, moderately dense, of young Hemlock near the run and Birch and hardwoods above named near top of slope.

Age of pine: 240 to 260 years. Density of crown cover: 0.4 to 0.5; openings near top of slope.

Number of trees per acre: 96.

YIELD FOR THE TWO ACRES.

White Pine.					Hemlock.			Oak.		
Number of trees.	Diameter (breast high).	Height.	Volume. Bole.	Volume. Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cu. ft.*	*Feet B. M.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
1	10	80	108	432	10	3 to 6	80 to 100	2	6 to 10	35 to 60
2	11	80			24	6 to 10		3	10 to 14	
1	13	80			3	11				
3	19	130	959	4,494	4	12			Birch.	
4	22	130			4	13				
1	23	130	190	1,000	5	14		5	3 to 6	40 to 60
5	25	130	1,085	6,150	9	15		10	6 to 10	
2	26	135	514	2,780	3	16		1	10 to 14	
2	27	135	1,995	9,800	7	17		1	14 to 18	
3	28	135			3	18				
2	29	135			8	19			Chestnut.	
3	30	135	915	5,850	5	20				
1	31	145	310	2,000	2	21		3	6 to 10	40 to 60
3	32	145	1,170	6,900	3	22		1	10 to 14	
5	33	145	2,400	14,400	8	23		1	14 to 18	
1	34	145			5	25				
2	35	145	960	5,600	1	26			Maple.	
2	39	145	3,066	19,800	3	27				
2	40	145			4	28		1	3 to 6	
1	41	145			2	30		3	6 to 10	
1	42	145			1	36		1	10 to 14	
47 trees: Total cubic feet			6,836		146 trees: Total cubic feet					
Total feet B. M			39,603		Total feet B. M					

Average annual accretion: All species, 49 cubic feet.
264 feet B. M.

MEASUREMENTS OF SAMPLE TREES.

Age class: 180 to 200 years.

Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume. Tree.	Volume. Merchantable timber.	Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem).
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cu. ft.*	*Feet B.M.*			
10	194	26.0	116	56	6.6	170.8	908	0.40	0.51	44
11	190	30.0	114	56	5.6	214.4	1,273	.38	.51	49
12	197	26.5	105	56	7.0	183.3	997	.45	.46	45
13	196	23.0	95	40	7.4	111.1	490	.40	.58	37
14	199	29.0	103	52	6.3	220.6	1,290	.46	.49	48
15	189	23.0	104	60	8.0	106.4	534	.35	.42	41
16	186	22.0	104	54	7.8	128.0	643	.46	.48	42
17	189	25.5	105	45	6.9	176.1	892	.47	.57	42
18	197	26.0	101	50	7.3	155.7	791	.42	.50	42
19	183	26.5	88	40	7.2	151.2	760	.45	.54	41
Average	193	26.0	103	51	7.0	162.0	858	.42	.51	43

Age class: 230 to 250 years.

DOMINANT GROWTH.

21	256	34.0	158	94	7.5	416.3	2,660	0.42	0.40	53
22	242	35.0	150	82	6.2	376.1	2,261	.37	.45	50
Average	249	34.5	154	88	6.8	396.0	2,460	.40	.42	51
4	201	40.0	129	64	5.0	401.7	2,300	.36	.50	47

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

C.—PENNSYLVANIA—Continued.

MEASUREMENTS OF SAMPLE TREES—Continued.

Age class: 230 to 250 years.

CODOMINANT GROWTH.

Tree number	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume. Tree.	Volume. Merchantable timber.	Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem)
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cu. ft.*	*Feet B. M.*			
1	245	28.5	132	94	7.0	256.6	1,583	0.44	0.29	51
2	232	23.0	132	78	9.3	160.6	766	.42	.41	39
20	256	23.5	141	96	10.1	192.7	1,066	.45	.32	46
Average	244	25.0	135	89	8.8	203.0	1,138	.44	.34	45
5	229	25.0	120	60	7.1	197.6	1,100	.48	.50	46
6	234	23.0	116	60	9.3	160.4	888	.48	.48	46
7	(1)	28.0	124	72	(1)	224.2	1,348	.42	.42	50
8	231	27.0	110	60	7.8	190.2	1,070	.43	.45	47
9	229	30.0	120	52	7.7	268.0	1,535	.45	.56	48
Average	231	26.5	118	61	8.0	208.0	1,188	.45	.48	47

(2) SITE *f*: Clearfield County. Sample area: 1 acre.

[1,200 to 1,500 feet above sea level.]

Soil.—Yellow clayey loam of medium grain (fine shales in it), deep, fresh, well drained, with 2 to 3 inches mold on top, and surface cover of scanty leaves, Fern, Teaberries, and scattering Dogwood (Laurel northeast corner and north side); subsoil, laminated shale of indefinite depth.

Forest conditions: Hemlock (62 per cent) mixed with White Pine (28 per cent), with occasional hardwoods (10 per cent), Maple, Beech, and Birch, on hill sloping toward southwest, bordered by left-hand branch of Narrow Creek; undergrowth, moderately dense, of very young Beech, Hemlock, and occasional Birch and Cucumber.

Age of pine: 240 to 260 years.
Density of crown cover: 0.7, in places, 0.8.

Number of trees: 132.

ACRE YIELD.

White Pine. Number of trees.	White Pine. Diameter (breast high).	White Pine. Height.	White Pine. Volume. Bole.	White Pine. Volume. Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
2	15	120	360	1,360
2	17	120		
2	18	130		
1	19	130		
1	20	130	1,370	6,420
4	21	130		
2	22	130		
2	23	130	570	3,000
1	24	130		
3	25	135	651	3,690
1	26	135	257	1,390
2	27	135		
1	28	135	1,140	6,600
1	29	135		
2	30	145	610	3,900
4	31	145	1,220	7,800
1	32	145	390	2,300
2	34	145	800	4,800
1	40	145	511	3,300
1	41	145	511	3,300
1	45	145	638	4,400
37 trees: Total cubic feet			9,028	
37 trees: Total feet B. M				52,260

Hemlock. Number of trees.	Hemlock. Diameter (breast high).	Hemlock. Height.
	Inches.	*Feet.*
17	6 to 10	80 to 100
4	10 to 14	
3	14	
4	15	
1	16	
8	17	
6	18	
6	19	
8	20	
5	21	
8	22	
3	23	
3	25	
1	26	
4	27	
3	28	
1	29	
1	30	
95 trees: Total cubic feet		15,686
95 trees: Total feet B. M		90,103

Maple. Number of trees.	Maple. Diameter (breast high).	Maple. Height.
	Inches.	*Feet.*
2	6 to 10	40 to 60
3	14 to 18	
Beech.		
2	10 to 14	50
1	14 to 18	
Birch.		
1	6 to 10	40
2	10 to 14	

Average annual accretion: All species, 61 cubic feet.
360 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

C.—PENNSYLVANIA—Continued.

MEASUREMENTS OF SAMPLE TREES.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume		Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem).
						Tree.	Merchantable timber.			
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cu. ft.*	*Ft. B. M.*			
1	260	35.5	158	90	7.6	435.4	3,030	0.40	0.43	58
2	260	36.0	157	90	7.0	481.3	3,401	.43	.42	59
3	259	32.0	152	84	7.8	396.0	2,637	.46	.44	55
4	241	32.0	150	62	6.6	347.7	2,079	.41	.59	50
10	244	33.0	146	96	6.8	365.9	2,384	.42	.34	54
12	262	28.0	156	88	9.0	285.8	1,648	.43	.43	47
18	265	39.0	153	88	6.0	511.1	3,318	.40	.42	54
19	250	34.0	150	78	6.3	402.4	2,397	.42	.48	49
20	266	44.0	144	100	5.7	638.1	4,388	.42	.30	57
21	245	34.0	146	92	7.1	366.7	2,248	.40	.37	51
23	248	34.0	142	90	7.2	373.4	2,318	.42	.37	51
33	259	33.0	133	91	8.0	304.5	1,770	.40	.31	48
34	262	33.0	146	90	7.4	369.2	2,220	.42	.38	50
35	263	31.0	144	82	8.5	275.2	1,458	.36	.43	44
36	241	31.5	134	88	7.1	307.7	1,853	.42	.34	50
37	261	37.0	146	106	6.7	482.9	2,970	.44	.27	50
Average	255	34	147	88	7.0	390.0	2,507	.41	.39	52

CODOMINANT GROWTH.

28	262	28.5	138	75	9.8	264.3	1,551	0.43	0.45	49
25	244	28.5	138	107	7.7	298.1	1,954	.49	.22	54
24	245	25.0	130	84	9.3	192.1	1,102	.43	.35	48
22	246	31.0	130	82	7.3	310.3	1,731	.45	.37	46
5	264	29.0	140	100	8.4	300.4	1,905	.47	.28	52
6	264	29.0	140	110	8.5	291.4	1,631	.45	.21	47
7	262	29.0	152	112	9.5	302.8	1,854	.46	.26	51
8	235	29.0	142	86	.....	248.6	1,318	.38	.39	44
9	236	32.0	142	84	.....	287.7	1,648	.36	.41	48
11	244	30.0	141	81	7.5	305.3	1,947	.44	.42	53
13	258	23.0	147	93	9.6	206.0	1,048	.48	.37	42
14	242	25.0	139	98	.....	217.1	1,233	.46	.30	47
15	262	26.0	136	98	.....	257.2	1,389	.51	.28	45
16	235	24.5	124	93	.....	163.8	815	.40	.25	41
17	262	25.0	128	108	.....	214.4	1,183	.49	.16	46
26	245	26.0	136	98	9.3	199.2	1,021	.40	.28	47
30	259	26.5	134	90	9.2	228.6	1,336	.44	.32	48
29	264	28.0	141	84	9.2	276.5	1,577	.46	.40	47
31	262	25.5	132	88	10.0	191.8	863	.41	.33	37
32	261	26.0	142	99	9.1	239.9	1,322	.46	.30	46
Average	253	27	138	93	9.0	250.0	1,421	.44	.32	47

OPPRESSED GROWTH.

27	259	19.0	132	94	11.6	138.8	683	0.53	0.29	41
38	260	23.0	137	96	11.1	189.6	987	.48	.30	43
39	258	20.5	123	109	13.0	130.9	558	.46	.11	35
40	261	16.5	120	82	13.7	89.6	339	.50	.31	31
Average	259	20.0	128	95	12.3	137.0	642	.49	.25	37

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

C. PENNSYLVANIA—Continued.

(3) SITE *h* — Clearfield County — Sample area—1 acre.

[1,200 to 1,500 feet above sea level.]

Soil: Yellow clayey loam, of medium grain, with fine shales, deep, fresh, well drained, with 2 to 3 inches mold on top, and surface cover of scanty leaves, Fern, Dogwood, and Blackberries; subsoil, laminated shale of indefinite depth.

Forest conditions: Hemlock (47 per cent) and White Pine (30 per cent) with scattering Beech and occasional Black Birch (hardwoods 23 per cent), undergrowth scanty, of young Beech with a few Black Birch and Basswood.

Age of pine: 240 to 260 years. Density of crown cover: 0.5 to 0.7 in places openings.

Number of trees: 78.

ACRE YIELD.

White Pine.					Hemlock.			Beech.		
			Volume.							
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M*		*Inches.*	*Feet*		*Inches.*	*Feet.*
1	18	130	137	642	1	3 to 6		16	6 to 10	30 to 40
1	20	130	137	642	2	7				
1	21	130	137	642	2	8				
1	22	130	137	642	1	9				
1	23	130	380	2,000	2	11		Black Birch.		
1	24	130			1	16				
2	26	135	514	2,780	4	17				
2	28	135	570	3,300	1	18		1	6 to 10	40
3	31	145	915	5,850	2	19	80 to 100	1	10 to 14	
4	32	145	1,560	9,200	3	20				
2	34	145	800	4,800	3	21				
1	35	145	960	6,400	2	23				
1	36	145			3	24				
1	40	145	1,022	6,600	1	25				
1	41	145			4	26				
					1	27				
					3	28				
					1	33				

23 trees:
Total cubic feet 7,269
Total feet B. M 43,490

55 trees:
Total cubic feet 11,224
Total feet B. M 66,900

Average annual accretion: All species, 45 cubic feet, 268 feet B. M.

(4) SITE *i*: — Jefferson County. — Sample area—1 acre.

[1,500 to 1,800 feet above sea level.]

Soil: Reddish-brown clayey loam, deep, fresh, well drained, with 2 to 3 inches mold on top and a surface cover of abundant leaves and ground Hemlock; subsoil, laminated shale of indefinite depth.

Forest conditions: Hardwoods (71 per cent), mainly Beech, White Oak, and Maple—mixed with Hemlock (22 per cent) and scattering White Pine (7 per cent) on ridge, undergrowth, moderately dense, of very young Beech and some Maple.

Age of pine: 230 to 240 years.

Density of crown cover: 0.7 in places 0.8.

Number of trees: 155.

ACRE YIELD.

White Pine.					Beech.			Maple.			Hemlock.		
			Volume.										
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.	Number of trees.	Diameter (breast high).	Height.	Number of trees.	Diameter (breast high).	Height	Number of trees.	Diameter (breast high).	Height
	Inches.	*Feet.*	*Cu. feet.*	*Feet B. M*		*Inches.*	*Feet.*		*Inches.*	*Feet.*		*Inches.*	*Feet.*
1	12	90	50.0	120	37	3 to 6	40 to 60	5	6 to 10	50 to 60	5	3 to 6	60 to 80
1	17	99	70.2	236	14	6 to 10		9	10 to 14		15	6 to 10	
1	19	102	90.3	386	17	10 to 14		2	14 to 18		4	10 to 14	
1	23	122	152.3	656	1	18 to 24		3	18 to 24		3	14 to 18	
1	24½	126	174.9	820							7	18 to 24	
1	30½	136	300.0	1,682							3	over 30	100
1	31½	140	278.2	1,425		White Oak.			Chestnut.				
1	35½	140	401.2	2,605									
2	37	147	949.4	5,755	1	14 to 18	80	2	3 to 6	20 to 30			
1	49	138	487.1	3,056	7	18 to 24							
					6	24 to 30							

11 trees:
Total cubic feet 2,933
Total feet B. M 16,741

144 trees:
Total cubic feet 5,526

Average annual accretion: White Pine, 12 cubic feet, 71 feet B. M.

TABLE VI.—*Acre yields of White Pine and measurements of sample trees*—Continued.

C.—PENNSYLVANIA—Continued.

MEASUREMENTS OF SAMPLE TREES.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume.		Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem).
						Tree.	Merchantable timber.			
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cubic feet.*	*Feet B. M.*			
1	228	30.5	136	80	5.6	300.0	1,682	0.43	0.41	47
2	239	40.0	138	80	5.6	487.1	3,056	.40	.42	52
3	234	37.0	146	72	5.4	482.8	2,626	.44	.51	45
4	240	31.5	140	86	9.6	278.2	1,425	.37	.39	42
5	239	37.0	148	96	6.1	466.6	3,129	.42	.35	56
6	239	35.5	140	80	6.1	401.2	2,605	.42	.43	54
Average	236	35.0	141	82	6.4	403.0	2,420	.41	.42	49

OPPRESSED GROWTH.

7	235	23.0	122	86	9.3	152.3	656	0.43	0.29	35
8	238	24.5	126	92	8.7	174.9	820	.42	.27	36
Average	236	23.5	124	89	9.0	163.0	738	.42	.28	35

SUPPRESSED GROWTH.

9	230 to 240	19	102	50	(?)	90.3	386	0.44	0.51	35
10		17	99	80	(?)	70.2	236	.44	.19	28
Average		18	100	65		80.0	311	.44	.35	31

(5) SITE *k*: Jefferson County.

[1,500 to 1,600 feet above sea level.]

Soil: Reddish-brown clayey loam, deep, fresh, and drained by Windfall Run.
Forest conditions: White Pine, with Hemlock and occasional hardwoods. Hemlock comparatively small, acting as an underwood, giving ample shade to the stems of the White Pine.

MEASUREMENTS OF SAMPLE TREES.

Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume.		Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem).
						Tree.	Merchantable timber.			
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cubic feet*	*Feet B.M.*			
11	247	32.5	146	96	6.3	398.0	2,221	0.47	0.34	46
12	241	35.0	176	90	7.3	499.2	3,003	.42	.49	50
13	238	32.5	142	96	6.2	359.7	2,053	.44	.32	48
14	236	32.5	158	96	8.2	386.3	2,244	.42	.40	48
15	238	34.0	148	96	6.2	382.4	2,236	.41	.35	49
16	241	30.0	143	96	8.0	322.2	1,832	.46	.33	47
17	233	31.0	145	90	6.5	323.4	2,464	.42	.38	63
18	227	29.5	142	88	6.6	255.8	1,591	.38	.38	45
19	342	32.0	153	100	7.2	335.5	1,985	.39	.34	46
20	236	35.0	158	112	6.2	485.3	2,795	.46	.29	48
21	240	34.5	152	90	6.2	396.8	2,312	.45	.41	49
22	236	32.5	158	92	5.8	387.9	2,245	.42	.41	48
Average	238	32.5	152	95	6.7	378.0	2,231	.43	.37	49

YIELD OF SECOND-GROWTH WHITE PINE, WITH MEASUREMENTS OF YOUNG PINE TAKEN FOR ANALYSIS.

The yield of second-growth White Pine on selected sample areas in the States named is shown in the following notes and tabulations, which also give, for illustration, the number of trees, volume, and average annual accretion of pine, the soil, forest conditions, acre yields, and measurements of sample young pines taken for analysis:

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis.*

A.—PENNSYLVANIA:

(1) SITE *c*: Luzerne County. Sample area, 1 acre.

[1,400 to 1,500 feet above sea level.]

Half acre No. 1.

Soil: Dark-brown loamy sand, medium grain, with pebbles and gravel, light, loose, deep, fresh, drained by Bear Creek and a number of other small streams, 2 inches mold on top, and a surface cover of abundant leaves and scanty fern. Age of pine: 60 to 80 years.

Forest conditions: White Pine, mixed with Maple, Beech, Hemlock, and scattering Yellow and White Birch, White and Red Oak, and occasional Black Cherry, in a valley sloping toward southwest and bordered on all sides by hills over 300 feet above station; undergrowth moderately dense, of young Hemlock, Beech, Maple, Birch.[1] Density of crown cover: 0.5. Number of trees: 216.

HALF-ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
2	6	50	11	
2	7	50	12	
2	8	50	19	
10	9	50	115	
4	10	50	60	
6	11	60	126	
6	12	60	150	
8	13	60	208	
8	14	60	210	
4	15	80	176	
4	16	80	184	
8	17	80	456	
2	18	80	135	
4	19	80	276	
6	20	80		
2	22	80	750	
2	23	80		
80 trees:				
Total cubic feet			2,918	
Total feet B. M.				14,006

Average annual accretion: White Pine, 41 cubic feet.

[1] *Intermixed species:* Maple, 68; Beech, 22; Hemlock, 18; Yellow and White Birch, 14; White and Red Oak, 12; Cherry 2. *Undergrowth:* Young Hemlock, 280; Beech, 146; Maple, 84; Birch, 12.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

A.—PENNSYLVANIA—Continued.

Half acre No. 2.

Soil: Reddish-brown sandy loam, fine grain, medium loose, deep, fresh, drained by Bear Creek, 2 to 3 inches mold on top, and surface cover of abundant leaves; Laurel and few Fern.
Forest conditions: White Pine (154) mixed with Maple, scattering Beech, Hemlock, and occasional Spruce, on uneven ground of a valley sloping toward northeast and bordered on all sides by hills over 300 feet above station; undergrowth, moderately dense, of young Hemlock, Beech, Maple, and a few young Spruce.[1]

Age of pine: 60 to 80 years.
Density of crown cover: 0.5 to 0.8.

Number of trees: 232.

HALF-ACRE YIELD.

White Pine.

Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B.M.*
14	3 to 6	40	.....	
2	6	50	11	
4	7	50	24	
12	8	50	114	
10	9	50	115	
14	10	50	210	
10	11	60	210	
8	12	60	200	
12	13	60	312	
16	14	60	480	
4	15	80	176	
4	16	80	184	
14	17	80	798	
8	19	80	552	
6	20	80		
6	21	80		
4	22	80	1,650	
4	24	80		
2	25	80		
154 trees:				
Total cubic feet				5,036
Total feet B.M.				24,173

Average annual accretion: White Pine, 72 cubic feet.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

Forest conditions: Ridge land densely covered with young hardwoods—mainly White Oak and Red Oak, among which White Pine is scattered.

Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume.		Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem).
						Tree.	Merchantable timber.			
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cubic feet.*	*Feet B.M.*			
1	123	29.0	84	34	3.5	140.6	627	0.36	0.60	37
2	132	20.0	81	20	5.7	78.1	369	.44	.75	*a* 39
3	134	22.0	81	16	5.7	81.6	369	.38	.80	*a* 38
4	128	31.0	90	20	3.8	193.8	935	.41	.77	40
Average	129	25.5	84	22	4.7	124.0	575	.40	.73	38

a Oppressed for the last forty years.

[1] *Intermixed species:* Maple, 36; Hemlock, 16; Beech, 18; Spruce, 8.
Undergrowth: Young Hemlock, 200; Beech, 66; Maple, 24.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

A.—PENNSYLVANIA—Continued.

Soil. Reddish-brown sandy loam, medium loose, fresh, deep, and well drained, with surface cover of abundant leaves.
Forest conditions. Hardwoods mainly Beech, Oak, Maple, Chestnut, and Birch mixed with White Pine, Pitch Pine, Hemlock, and occasional Spruce.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume.		Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem).
						Tree.	Merchantable timber.			
	Years.	*Inches.*	*Feet.*	*Feet*	*No.*	*Cubic feet.*	*Feet B. M.*			
1	163	29	116	50	5.0	191.4	947	0.36	0.57	40
1	98	25.0	84	32	3.5	121.2	530	.42	.62	36
2	96	20.0	73	32	4.3	76.1	360	.48	.56	40
3	92	31.0	97	32	2.5	210.0	976	.41	.67	40
4	97	19.5	76	26	4.3	67.0	363	.42	.66	45
Average	96	24.0	82	30	3.5	118.0	557	.43	.63	40

Soil. Fresh sand, well drained.
Forest conditions. A young White Pine grove mixed with mature Spruce, Hemlock, and scattering hardwoods.

Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume.		Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem).
						Tree.	Merchantable timber.			
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cubic feet*	*Feet B. M*			
1	64	14.5	54	18	4.0	28.7	110	0.46	0.66	31
2	57	11.5	58	20	2.7	31.4	144	.47	.66	38
3	50	8.5	50	20	4.8	9.5	43	.48	.60	36
4	47	8.0	46	18	5.0	7.3	32	.45	.61	37
5	52	11.0	50	20	3.7	14.2	54	.43	.60	31
6	49	11.5	46	18	3.6	15.7	59	.47	61	31
7	52	9.5	53	18	4.0	12.1	48	.46	.66	33
8	54	8.0	54	18	5.7	10.1	34	.53	.66	27
9	54	10.0	56	18	4.3	14.7	59	.48	.68	33
Average	53	10.5	52	19	4.2	16.0	65	.47	.64	33

(2) SITE *c*: Clinton County. Sample area: 1 acre.

[1,500 to 1,600 feet above sea level.]

Soil. Loamy sand with rocks on face of slope, the brown-yellowish coarse grain full of shales, surface cover of 2 to 3 inches mold and abundant leaves.
Forest conditions. Brush of very young White, Red, and Chestnut Oak, with scattering White Pine (14) and occasional Chestnut Oak (6), Jack Pine (3), and Norway Pine (2), on a steep hill 300 feet above station, facing south; undergrowth, dense, of young hardwoods of same species as above.

Age of pine: 120 to 130 years. Density of crown cover: 0.2 (scattered).

Number of trees: 25.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
1	10	70	19	.....
1	15	76	46	161
1	19	84	66	370
3	21	85	270	1,245
1	22	87	99	432
3	24	85	345	1,449
3	25	85	372	2,004
1	29	85	151	760
14 trees:				
Total cubic feet				1,368
Total feet B. M				6,421

Average annual accretion. White Pine, 11 cubic feet, 57 feet B. M

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

A.—PENNSYLVANIA—Continued.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume.		Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice (per cent used of total volume of stem).
						Tree.	Merchantable timber.			
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cubic feet.*	*Feet B. M.*			
1	125	21.0	78	40	4.8	88.6	404	0.47	0.48	39
2	124	24.0	86	28	5.4	115.8	483	.42	.67	34
3	124	22.0	87	34	5.5	99.0	432	.43	.61	36
4	116	18.5	79	36	6.2	63.9	280	.43	.54	36
5	122	19.5	85	40	5.0	79.7	364	.45	.53	38
6	(*l*)	24.5	83	36	(*l*)	124.5	668	.46	.56	44
7	120	21.0	89	38	5.4	94.5	429	.44	.57	37
8	128	19.0	81	40	6.4	66.2	370	.40	.52	46
9	127	19.5	88	40	5.7	92.0	446	.50	.54	40
10	122	15.0	76	36	7.1	46.2	161	.49	.52	30
11	125	17.0	84	36	6.9	61.4	267	.46	.57	36
12	(*l*)	20.5	76	38	(*l*)	78.0	293	.45	.50	31
Average...	123	20	83	37	6.0	84.0	383	.45	.55	37

(3) SITE *g*: Clearfield County. Sample area: 1 acre.

[1,200 to 1,500 feet above sea level.]

Soil: Yellow clayey loam, medium grain, deep, fresh, well drained (three small streams cross the hollow in different directions), with 2 to 3 inches mold on top, surface cover of leaves, Fern, Ground Pine, Wintergreen, Elderberry, Blackberry, and Dogwood; subsoil laminated shale of indefinite depth.

Forest conditions: Young White Pine intermixed with young hardwoods in hollow extending north and south, and bounded on the west by hill over 2 feet above station; undergrowth dense, of very small and various hardwoods, mainly Black Birch, Maple, and Beech, and few White Birch and Hemlock.[1]

Age of pine: 25 to 35 years.

Density of crown cover: 0.5 to 0.6.

Number of trees: (*l*)

ACRE YIELD

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
154	Under 3	.....	4.5	
41	3 to 5	16 to 37	61.5	
54	6 to 10	40 to 47	432.0	
34	10 to 14	42 to 50	612.0	
2	14 to 18	.....	42.0	
285 trees; Total cubic feet			1,152	

Average annual accretion: White Pine, 38 cubic feet.

[1] *Intermixed species:* White Pine, 131+154 small; Aspen, 12+54 small; Beech, 1+137 small; Maple, 6+254 small; Oak, 5+12 small; White Ash, 3+21 small; Cucumber, 6+90 small; Black Cherry, 2+77 small; Black Birch, 17+415 small; Hamamelis, 4 small; Basswood, 6 small; Tulip, 13 small; Ironwood, 2 small; Chestnut, 2 small; Willow, 10 small; Hemlock, 50 small.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

A.—PENNSYLVANIA—Continued.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high)	Height.	Height to base of crown.	Rings per inch on stump	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.
	Years.	*Inches.*	*Feet.*	*Feet*	*No.*	*Cubic ft.*		
10	33	13.5	43.8	11.0	1.6	21.0	0.48	0.75
17	36	14.0	47.0	14.0	1.9	20.9	41	.70
9	35	12.5	49.0	18.5	2.1	18.8	45	.62
11	34	13.5	43.0	12.0	1.9	18.1	42	.72
Average	34	13.4	46.0	14.0	1.9	19.7	.44	.70

CODOMINANT GROWTH.

14	32	11.2	42.5	19.5	1.7	12.6	0.45	0.54
15	31	9.5	47.0	28.0	2.5	10.9	.47	.40
16	34	8.0	45.0	28.0	3.1	7.7	.48	.38
7	34	8.0	41.8	22.5	3.5	6.7	.45	.46
13	34	7.2	41.5	14.8	3.9	5.2	.47	.64
Average	33	8.8	43.0	22.0	2.9	8.6	.46	.48

OPPRESSED GROWTH.

6	31	6.0	39.8	25.0	3.8	4.0	0.51	0.37
8	33	5.2	37.0	21.5	4.7	2.8	.55	.42
12	29	5.0	32.5	14.0	4.3	2.1	.48	.57
Average	31	5.4	36.0	20.0	4.3	3.0	.51	.45

SUPPRESSED GROWTH.

5	27	3.0	27.0	13.0	7.0	0.7	0.53	0.51
2	30	3.3	23.5	9.0	7.9	.7	.44	.61
3	27	3.1	27.8	14.0	7.4	.6	.47	.49
Average	27	3.1	26.0	12.0	7.4	.7	.48	.54
1	22	3.0	16.0	16.0	4.8	1	.59	1.00
4	24	2.5	24.0	7.0	5.9	.3	.41	.71
Average	23	2.7	20.0	11.0	5.3	.3	.50	.85

(4) SITE *y*. Forest County. Sample area: 1 acre.

[1,100 to 1,200 feet above sea level.]

Soil: Yellowish-brown clayey loam, with shales, deep, fresh, drained on south by Beaver Creek and on the west by Hickory Creek, 3 to 4 inches mold on top, and surface cover of leaves and Fern; subsoil, laminated shale of indefinite depth.

Forest conditions: Young White Pine intermixed with hardwoods and occasional Hemlock on slope facing southwest, undergrowth dense, of very young Hemlock Birch, Beech, some Maple and Ironwood, and a few other hardwoods.[1]

Age of pine: 40 to 50 years.
Density of crown cover: 0.8 (in places thick and crowded, and in other places openings).
Number of trees: (?).

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches	*Feet*	*Cubic feet.*	*Feet B. M.*
144	3 and under 4	20 to 40	53	
41	4			
49	5	46		
34	6	46	572	
23	7	46		
24	8	54		
28	9	54	839	
21	10	54		
12	11	58		
4	12	58	306	
1	13	58		
1	14	61	56	
1	15	61		
383 trees: Total cubic feet				1,826

Average annual accretion. White Pine, 40 cubic feet.

[1] *Intermixed species.* White Pine, 239+144 small; Hemlock 78+248 small; Beech, 50+160 small; Maple, 46+108 small; Oak (White and Red), 20+12 small; Ash, 16+9 small; Black Birch, 73+76 small; Yellow Birch, 59+189 small; Ironwood, 13+100 small; Black Cherry, 15+2 small; Hickory, 2; Cucumber, 2; Juneberry 50; few small Aspen, Butternut, and Waterbeech.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

A.—PENNSYLVANIA—Continued.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

DOMINANT GROWTH.

Tree number	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.
	Years.	*Inches.*	*Feet.*	*Feet.*	*No.*	*Cubic ft.*		
3	46	12.0	60.0	23	3.5	20.2	0.43	0.62
12	44	11.5	58.5	26	3.4	20.0	.47	.55
2	44	12.5	55.0	18	3.4	19.4	.41	.67
8	47	11.0	59.0	30	3.3	18.7	.48	.49
16	47	11.5	66.0	28	3.3	18.3	.45	.50
9	45	11.0	58.5	28	2.7	17.9	.49	.52
5	47	10.5	60.0	34	3.7	17.3	.48	.43
6	47	10.0	59.0	32	3.3	16.4	.51	.46
21	48	10.5	58.0	30	3.6	16.3	.46	.48
19	47	11.0	55.0	28	3.1	15.4	.42	.49
Average	46	11.0	58.0	28	3.3	18.0	.45	.52
7	47	14.0	64.0	34	2.9	29.6	.43	.47
15	46	14.0	58.0	22	3.0	26.9	.43	.62
Average	46	14.0	61.0	28	3.0	28.2	.43	.54

CODOMINANT GROWTH.

18	43	9.5	56.0	28	4.1	13.9	0.50	0.50
14	43	10.0	52.5	30	4.2	13.9	.48	.43
24	46	10.0	53.0	28	3.9	13.7	.47	.47
11	45	9.5	58.0	30	4.9	13.1	.46	.48
17	44	9.0	58.0	32	3.9	12.9	.47	.44
4	45	9.0	46.0	23	4.9	11.4	.46	.59
26	45	8.5	50.0	30	4.6	10.0	.51	.40
13	43	8.0	54.0	28	3.7	9.6	.51	.48
1	47	8.0	50.0	20	5.1	9.2	.53	.60
10	44	8.0	56.0	36	5.1	8.6	.44	.53
Average	44	9.0	54.0	28	4.4	11.5	.48	.49

OPPRESSED GROWTH.

27	43	7.5	48	22	5.0	7.9	0.54	0.54
20	42	7.0	46	30	5.0	6.6	.53	.34
25	43	7.5	46	30	5.2	6.1	.43	.35
22	43	5.0	45	28	6.9	3.1	.50	.38
23	44	5.5	46	38	6.8	3.6	.47	.17
Average	43	6.5	46	30	5.8	5.4	.49	.35

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

B.—MAINE:

(1) SITE *a*: York County.

Sample area: One half acre.

Soil: Gray or brown fine loamy sand, deep, fresh, 2 to 3 inches mold on top and leafy surface cover, and clay probably some feet below surface.

Age of pine: 90 to 100 years.

Forest conditions: White Pine, with scattering Red Oak and White Oak and occasional Norway Pine on a level, undergrowth, moderately dense, of small Hemlock and Beech and numerous small Maple and Oak.

Density of crown cover: 0.5.

Number of trees: 118.

Classification:

	White Pine.
Dominant	per cent.. 26
Codominant	do.... 40
Oppressed	do.... 18
Suppressed	do ... 16

HALF ACRE YIELD.

White Pine.				
			Volume.	
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
2	10	75	42	
8	11	75	192	
8	12	75	233	
4	12	85	120	
6	13	85	222	
4	14	75	151	
8	14	85	332	
8	15	85	384	
8	16	85	408	
8	17	85	528	
10	18	85	690	
18	19	85	1,323	
2	20	85	152	
4	21	85	320	
6	22	85	534	
6	23	85	660	
3	24	95	250	
2	25	95	280	
4	26	95	560	
118 trees: Total cubic feet			7,383	

Average annual accretion: White Pine, 77 cubic feet.
Current annual accretion: White Pine, 160 cubic feet.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

Age class: 90 to 100 years.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
								Per cent.	*Cu. ft.*	*Cu. ft.*
	Years.	*Inches.*	*Feet.*	*No.*	*Cubic ft.*					
7	98	28.0	100	2.9	175.3	0.41	0.60			
12	92	28.0	103	2.7	161.0	.36	.61			
3	98	25.0	92	3.2	140.3	.46	.48			
17	92	25.5	91	3.0	136.3	.42	.56			
18	92	25.0	88	3.2	131.7	.41	.46			
23	97	22.0	98	3.8	119.4	.46	.49			
21	97	20.6	102	4.1	118.1	.35	.45			
16	90	22.5	91	3.4	115.1	.46	.52			
9	102	20.0	100	4.1	104.0	.47	.43			
20	100	20.3	103	4.3	98.8	.41	.40			
Average	96	23.7	97	3.5	130.0	.42	.50			

CODOMINANT GROWTH.

4	101	20.5	95	3.8	93.3	0.43	0.40			
8	98	19.5	99	3.8	88.4	.43	.33			
22	98	19.0	96	4.1	84.9	.45	.35			
10	89	16.8	99	3.8	71.3	.46	.40			
14	93	18.5	92	4.3	69.9	.41	.52			
28	93	18.5	89	4.6	68.4	.48	.41			
19	89	18.7	79	4.1	67.2	.45	.48			
15	99	17.2	87	4.6	67.0	.49	.46			
11	89	17.2	89	4.0	60.7	.43	.38			
Average	94	18.5	91	4.1	74.5	.45	.41			

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

B.—MAINE—Continued.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES—Continued.

OPPRESSED GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cubic ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
25	100	15.0	93	5.1	55.5	0.48	0.27			
1	100	15.0	90	6.5	55.3	.51	.36			
26	99	14.0	90	6.0	47.3	.49	.21			
6	86	14.3	88	5.0	43.1	.42	.18			
24	97	13.5	81	5.8	37.3	.46	.20			
5	99	12.6	86	7.2	37.1	.50	.14			
13	91	13.2	80	5.2	35.9	.48	.30			
27	99	12.0	80	6.3	30.7	.49	.22			
Average...	96	13.7	86	6.0	42.8	.48	.23			

Age class: 50 to 60 years.

DOMINANT GROWTH.

2	55	14.0	61	3.2	34.2	0.52	0.69	5.4	1.85	0.62
1	60	14.7	69	3.3	39.8	.50	.47	4.0	1.59	.66
3	60	17.0	61	3.1	42.8	.41	.64	4.6	1.97	.71
4	59	19.1	65	2.8	60.7	.47	.69	4.4	2.67	1.03
Average...	58.5	16.2	64	3.1	44.4	.48	.62	4.6	2.02	.75

(2) SITE *c*: York County. Sample area: 1 acre.

One-fourth acre No. 1.

Soil: Gray sand, sometimes brown or loamy, deep, fresh, with 3 inches vegetable mold, and a leafy surface cover; subsoil clayey, probably 4 or 5 feet below surface.
Forest conditions: White Pine, with scattering Hemlock and occasional Spruce and Fir, on a level plain; undergrowth, scanty, of Hazel and young Hemlock.[1]

Age of pine: 50 to 60 years.
Density of crown cover: 0.7
Number of trees: 328.

Classification:

	White Pine.
Dominant	per cent.. 9
Codominant	do.... 45
Oppressed	do.... 23
Suppressed	do.... 23

ONE-FOURTH ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B.M.*
4	6	45	20	
32	7	55	256	
60	7	45	330	
84	8	55	840	
8	8	45	72	
36	9	55	414	
8	10	65	144	
52	10	55	780	
8	11	.....	144	
12	12	65	306	
12	12	55	240	
4	13	65	116	
8	17	75	408	
328 trees: Total cubic feet			4,070	

Average annual accretion: White Pine, 74 cubic feet.
Current annual accretion: White Pine, 133 cubic feet.

[1] *Intermixed species.* Young White Pine, 160; Hemlock, 20 mature and 20 small.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

B. MAINE—Continued.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.
	Years.	*Inches.*	*Feet.*	*No.*	*Cubic feet.*		
9	50	14.5	64	2.8	33.1	0.45	0.55
4	59	13.3	60	3.8	26.4	.44	.58
8	55	12.8	61	3.3	25.6	.45	.38
3	50	11.8	58	3.5	20.1	.52	.41
10	50	10.2	65	4.4	22.0	.59	.35
12	50	11.0	62	3.7	21.1	.50	.35
Average...	51	12.3	62	3.6	24.7	.49	.44

CODOMINANT GROWTH.

11	52	10.0	59	4.3	16.1	0.50	0.40
5	50	9.0	58	4.3	13.4	.52	.41
20	51	8.8	58	4.6	13.3	.54	.38
7	50	9.4	54	4.3	12.3	.46	(?)
27	51	8.1	56	5.1	10.7	.55	.35
6	50	8.4	55	4.5	10.6	.50	.40
1	49	8.1	56	5.0	10.2	.52	.31
29	52	8.0	57	5.5	10.1	.50	.37
Average...	51	8.7	57	4.7	12.1	.51	.39

OPPRESSED GROWTH.

22	49	7.7	53	5.2	9.6	0.56	0.30
2	52	7.8	54	5.0	9.5	.50	.26
21	49	8.0	51	5.0	9.5	.53	.39
30	48	7.7	54	5.1	9.0	.52	.40
25	50	7.4	58	5.6	9.0	.50	.33
19	51	8.2	47	5.1	8.9	.51	.34
17	50	7.4	54	5.6	8.0	.50	.30
Average...	50	7.8	73	5.2	9.1	.52	.33

SUPPRESSED GROWTH.

14	55	6.3	57	(?)	6.3	0.51	0.31
16	48	6.9	49	5.7	5.8	.44	.28
26	46	6.3	51	5.5	5.5	.47	.25
13	46	6.2	47	5.8	5.1	.51	.27
15	48	5.6	50	7.0	4.3	.52	.20
28	50	6.0	39	8.0	3.7	.48	.56
23	48	5.3	46	7.6	3.6	.47	.26
24	52	5.0	48	8.3	3.4	.52	.43
18	52	5.0	46	10.0	3.2	.50	.27
Average...	50	5.8	48	7.2	4.5	.49	.31

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

B.—MAINE Continued.

One-fourth acre No. 2.

Soil: Brown sandy loam with little pebbles in it, deep, fresh, 3 inches black soil and mold on top, and leafy surface cover; clay probably 8 to 12 inches below surface. Age of pine: 50 to 60 years. Density of crown cover: 0.8
Forest conditions: White Pine, with occasional Norway Pine, on a slope to north 5 to 10°; undergrowth scanty, of Hemlock, Oak, and Fir. Number of trees: 396.

Classification:

	White Pine.
Dominant	18 per cent.
Codominant	27 do.
Oppressed	24 do.
Suppressed	31 do.

ONE-FOURTH ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
4	6	65	28	
28	6	55	168	
20	7	65	190	
20	7	55	160	
84	8	65	1,008	
24	8	55	240	
36	9	65	522	
32	10	65	576	
8	10	75	168	
40	11	65	880	
4	11	75	100	
16	12	65	408	
24	12	75	696	
8	13	65	232	
16	13	75	552	
4	14	65	132	
12	14	75	462	
8	15	65	292	
4	16	75	184	
4	17	75	204	
396 trees: Total cubic feet			7,202	

Average annual accretion: White Pine, 131 cubic feet.

One-half acre No. 3.

Soil: Brown sand, deep, fresh, and leafy surface cover; clay probably 4 to 6 feet below surface. Age of pine: 50 to 60 years.
Forest conditions: White Pine intermixed with Norway Pine and occasional Spruce and Fir, on a slope to north; undergrowth scanty, of small and few Hemlock, Fir, and Spruce. Density of crown cover: 0.8. Number of trees: 314.

Classification:

	White Pine.
Dominant	8 per cent.
Codominant	36 do.
Oppressed	30 do.
Suppressed	26 do.

HALF-ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
18	7	65	162	
48	7	55	384	
60	8	65	720	
26	8	55	260	
44	9	65	638	
6	9	55	60	
4	10	75	82	
38	10	65	684	
10	11	75	250	
28	11	65	616	
4	12	75	116	
14	12	65	357	
4	13	75	138	
6	13	65	174	
2	14	75	77	
2	15	65	73	
314 trees: Total cubic feet			4,800	

Average annual accretion: White Pine, 87 cubic feet.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

B.—MAINE—Continued.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

DOMINANT GROWTH.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.
	Years.	*Inches.*	*Feet.*	*No.*	*Cu. ft.*		
7	89	21.8	86	3.7	89.3	0.40	0.42
8	85	19.6	85	4.0	76.5	.43	.50
5	92	17.3	87	4.4	69.5	.48	.52
13	92	19.3	79	4.2	69.3	.42	.47
2	82	18.8	80	3.8	68.6	.44	.39
10	82	17.7	85	4.4	67.4	.46	.41
14	96	18.5	75	4.4	66.6	.42	.46
11	91	17.2	85	4.5	66.4	.49	.48
15	94	17.2	82	4.4	63.7	.49	.45
Average	89	18.6	83	4.2	70.8	.45	.46
9	89	24.0	85	3.3	123.5	.45	.51

SUPPRESSED GROWTH.

3	100	12.6	57	8.0	24.9	0.50	0.54
1	190	10.0	69	8.7	20.1	.53	.39
Average	95	11.3	63	8.3	22.5	.51	.46

PENOBSCOT COUNTY.

Tree number.	Age.	Diameter (breast high).	Height.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*Cu. ft.*			*Per cent.*	*Cu. ft.*	*Cu. ft.*
9	66	12.5	76	31.83	0.49	0.40	2.8	0.89	0.48
1	77	16.0	62	34.55	.39	.69	3.3	1.14	.44
7	73	12.7	80	35.51	.52	.45	3.7	1.31	.48
10	74	13.0	80	36.00	.48	.40	3.1	1.12	.48
6	70	13.0	77	35.15	.50	.52	3.0	1.05	.50
8	69	13.2	82	38.49	.51	.35	3.6	1.38	.55
3	73	13.5	83	40.43	.49	.32	2.1	.85	.55
5	75	14.7	83	43.20	.45	.35	2.5	1.08	.57
1	70	15.7	81	42.34	.40	.43	3.6	1.51	.60
4	73	14.5	82	45.10	.47	.39	3.2	1.44	.61
2	79	17.0	74	51.14	.43	.43	2.0	1.02	.65
3	77	16.5	78	51.28	.44	.65	3.8	1.95	.66
2	72	15.2	85	51.91	.48	.30	2.0	1.04	.72
Average	73	14.4	79	41.30	.46	.41	3.0	1.21	.56

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

C.—MASSACHUSETTS:

(1) SITE *a*: Holbrook, Norfolk County. Sample area: 1 acre.

Soil: Yellowish-brown sandy loam, shallow, loose, dry, with 1 or 2 inches mold on top and a moderately leafy surface cover; subsoil, sand with stones and gravel. Age of pine: 35 to 38 years. Density of crown cover: 0.6.

Forest conditions: White Pine on a slope (angle about 10°); undergrowth scanty, of Red Cedar with scattering Hemlock and White and Red Oak.[1] Number of trees: 286.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
169	8	60	1,690	
5	10	60	80	
18	10	70	342	
24	11	70	528	
23	12	70	598	
28	13	70	868	
11	14	70	385	
7	15	70	280	
1	17	70	51	
286 trees: Total cubic feet			4,822	

Average annual accretion: White Pine, 131 cubic feet.

(2) SITE *b*: Pembroke, Plymouth County. Sample area: 1 acre.

Soil. Yellowish-brown sandy loam, medium grain, light, loose, fresh, with 2 to 3 inches mold on top and surface cover of abundant leaves. Age of pine: 50 to 55 years. Density of crown cover: Thick and quite even.

Forest conditions: White Pine with scattering Oak, Maple, Gray Birch, and occasional Sassafras and Hornbeam; undergrowth moderately dense of above species of hardwoods.[2] Number of trees: 339.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
226	8	60	2,260	
19	10	60	304	
18	10	70	342	
38	11	70	836	
22	12	70	572	
10	13	70	310	
2	14	70	70	
3	15	70	120	
1	16	70	45	
339 trees: Total cubic feet			4,859	

Average annual accretion: White Pine, 92 cubic feet.

[1] *Intermixed species:* Red Cedar, 2 from 6 to 10 inches diameter and under 60 feet high; 8 from 3 to 6 inches diameter and under 40 feet high. Red Oak, 1 over 6 inches diameter and under 60 feet high; 1 over 3 inches diameter and under 40 feet high. Hemlock, 4 from 3 to 6 inches diameter and under 40 feet high. White Oak, 3 from 3 to 6 inches diameter and under 40 feet high. Young White Pine, 85.
Undergrowth: Red Cedar, 29; White Oak, 1; and Hemlock, 3.

[2] *Intermixed species:* Oak, 10 from 10 to 14 inches diameter and under 80 feet high; 1 over 6 inches diameter and over 60 feet high; 6 from 6 to 10 inches diameter and under 60 feet high; 2 from 3 to 6 inches diameter and over 40 feet high. Maple, 4 from 3 to 6 inches diameter and over 40 feet high; 8 from 3 to 6 inches diameter and under 40 feet high. Gray Birch, 1 over 6 inches diameter and over 60 feet high; 6 from 6 to 10 inches diameter and under 60 feet high; 43 from 3 to 6 inches diameter and over 40 feet high. Young White Pine, 69.
Undergrowth: Gray Birch, 21; Maple, 38; Hornbeam, 1, and Sassafras, 3.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

C.—MASSACHUSETTS—Continued.

(3) SITE *c*. Hanson, Plymouth County. Sample area: 1 acre.

Soil. Yellowish loamy sand, medium grain, porous, light, loose, deep, dry, and well drained, with about 2 inches mold on top and surface cover of abundant leaves; subsoil, sand and gravel. Age of pine: 50 to 55 years. Density of crown cover: (?)

Forest conditions: Pure White Pine on level plain, originally mixed with hardwoods, but ten years ago hardwoods and dying pine cut out, leaving young oaks 1 to 2 feet high throughout site; undergrowth of hardwoods.[1] Number of trees: 310.

ACRE YIELD.

White Pine.				
			Volume.	
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
127	8	55	1,143	
19	10	55	285	
21	10	70	399	
39	11	70	858	
31	12	70	806	
23	13	70	713	
22	14	70	770	
16	15	70	640	
8	16	70	360	
2	17	70	102	
2	18	70	112	
310 trees: Total cubic feet			6,188	

Average annual accretion: White Pine, 123 cubic feet.

(4) SITE *d*. Weymouth, Norfolk County. Sample area: 1 acre.

[180 feet above sea level.]

Soil: Brown or yellow sandy loam, medium grain, shallow, light, loose, dry, and well drained, with 1 or 2 inches mold on top and surface cover of abundant leaves; subsoil, gravel and stone. Age of pine: 50 years. Density of crown cover: (?)

Forest conditions: White Pine, with scattering Red Oak and occasional Maple and Hornbeam on somewhat hilly site; undergrowth dense, of White Oak, Red Oak, Gray Birch, and Black Birch.[2] Number of trees: 295.

ACRE YIELD.

White Pine.				
			Volume.	
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
174	8	60	1,740	
36	10	65	612	
26	11	70	572	
21	12	70	546	
16	13	70	496	
10	14	70	350	
4	15	70	160	
3	16	70	135	
1	17	70	51	
3	19	70	183	
1	21	70	78	
295 trees: Total cubic feet			4,923	

Average annual accretion: White Pine, 98 cubic feet.

[1] *Undergrowth:* Hemlock, 7; Maple, 1; Red Cedar, 1; Black Birch, 4; Cherry, 4; Poplar, 1; White Oak, 1, with numerous small oaks.

[2] *Intermixed species:* White Oak, 5 from 3 to 6 inches diameter and over 40 feet high; 16 from 3 to 6 inches diameter and under 40 feet high; Gray Birch, 8 from 3 to 6 inches diameter and over 40 feet high; 7 from 3 to 6 inches diameter and under 40 feet high. Red Oak, 2 from 10 to 14 inches diameter and under 80 feet high; 20 from 6 to 10 inches diameter and under 60 feet high, 12 from 3 to 6 inches diameter and over 40 feet high, 23 from 3 to 6 inches diameter and under 40 feet high. Cherry, 1 over 3 inches diameter and under 40 feet high. Black Birch, 2 from 3 to 6 inches diameter and under 40 feet high. Red Cedar, 1 over 3 inches diameter and under 40 feet high. Maple, 1 over 3 inches diameter and over 40 feet high. Young White Pine, 47.

Undergrowth: White Oak, 35, and numerous small ones; Cherry, 2; Red Cedar, 1; Red Oak, 4; Black Birch, 19, and numerous small ones; Hemlock, 1; Gray Birch, 2; Hornbeam, 1.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

C.—MASSACHUSETTS—Continued.

(5) SITE *e*. Bridgewater, Plymouth County. Sample area: 1 acre.

[100 feet above sea level.]

Soil: Dark brown loamy sand, medium grain, light, loose, shallow, fresh, with about 2 inches mold on top, and surface cover of abundant leaves; subsoil, yellow fine sand. Age of pine: 45 years. Density of crown cover: (?)

Forest conditions. Cultivated White Pine, with occasional Gray Birch, on level plain; undergrowth of scattering Oak and Maple.[1] Number of trees: 374.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
240	8	55	2,160	
1	10	55	15	
42	10	60	672	
22	11	60	418	
27	12	60	621	
15	13	60	390	
13	14	65	429	
6	15	65	222	
2	16	65	84	
4	17	70	204	
2	18	70	112	
374 trees: Total cubic feet			5,327	

Average annual accretion White Pine, 118 cubic feet.

(6) SITE *f*. Bridgewater, Plymouth County. Sample area: 1 acre.

[100 feet above sea level.]

Soil. Light-brown sandy loam, medium grain, shallow, light, loose, dry, well drained, with about 2 inches mold on top, and surface cover of abundant leaves; subsoil, gravel of all sizes. Age of pine: 25 years. Density of crown cover: (?).

Forest conditions. Cultivated White Pine, intermixed with young hardwoods and Pitch Pine. (Pine seedlings from woods, 1 to 2 feet high, set in furrows at 6 or 8 feet each way.)[2] Number of trees: 560.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
115	3	20	.....	
184	3 to 6	30	.....	
211	6 to 8	30	1,055	
47	8 to 10	30	423	
1	10	35	11	
2	14	35	46	
560 trees: Total cubic feet			1,536	

Average annual accretion: White Pine, 61 cubic feet.

[1] *Intermixed species:* Gray Birch, 4 from 6 to 10 inches diameter and under 60 feet high; 7 from 3 to 6 inches diameter and over 40 feet high. *Undergrowth:* White Oak, 24; Maple, 3.

[2] *Intermixed species:* Gray Birch, 13 from 3 to 6 inches diameter and under 30 feet high. Pitch Pine, 1 over 8 inches diameter and under 30 feet high, 5 from 6 to 8 inches diameter and under 30 feet high; 28 from 3 to 6 inches diameter and under 30 feet high. Red Cedar, 1 over 3 inches diameter and under 30 feet high.
Undergrowth: Oak, 97; Gray Birch, 54; Pitch Pine, 16; Maple, 8; Cherry, 3; Hickory, 1.

TABLE VII.—*Acre yields of second growth White Pine, with measurements of young pine taken for analysis*—Continued.

C.—MASSACHUSETTS—Continued.

(7) SITE *g*: Grafton, Middlesex County. Sample area: 1 acre.

[500 feet above sea level.]

Soil: Brown, nearly black, sandy loam, medium grain, shallow, fresh, well drained, with 1 or 2 inches mold on top, and moderately leafy surface cover; subsoil, rock on ridge, yellowish sand on low ground.
Forest conditions: White Pine on hill; undergrowth, dense, of Maple and Oak and some Chestnut, Cherry, Gray Birch, and other hardwoods.[1]

Age of pine: 40 years.
Density of crown cover: 0.8 to 1.2.
Number of trees: 323.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
176	8	60	1,760	
2	10	60	32	
43	10	70	817	
44	11	70	968	
23	12	70	598	
21	13	70	651	
8	14	70	280	
4	15	70	160	
2	18	70	112	
323 trees: Total cubic feet			5,378	

Average annual accretion—White Pine, 134 cubic feet.

(8) SITE *h*: Worcester, Worcester County. Sample area: 1 acre.

[About 600 feet above sea level.]

Soil: Brown sandy loam, medium grain, deep, fresh, well drained, with about 1 inch mold on top and a moderately leafy surface cover; subsoil, drift gravel and stones.
Forest conditions: White Pine, with scattering Gray Birch and occasional Poplar and Pitch Pine on a hill; undergrowth, scanty, of Hemlock.[2]

Age of pine: 30 to 35 years.
Density of crown cover: 0.6 to 0.8 (in places 0.2 and 0.4).
Number of trees: 301.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
193	8	60	1,930	
39	10	70	741	
34	11	70	748	
13	12	70	338	
12	13	70	372	
5	14	70	175	
3	15	70	120	
1	16	70	45	
1	17	70	51	
301 trees Total cubic feet			4,520	

Average annual accretion—White Pine, 141 cubic feet.

[1] *Intermixed species:* Pitch Pine, 1 over 3 inches diameter and over 40 feet high; 1 over 6 inches diameter and under 60 feet high; 1 over 10 inches diameter and under 80 feet high. White Birch, 2 from 3 to 6 inches diameter and over 40 feet high. Gray Birch, 6 from 3 to 6 inches diameter and under 40 feet high. Young White Pine, 35.
Undergrowth (under 3 inches diameter and under 40 feet high): Maple, 204 (mostly Striped Maple); Oak, 133; Chestnut, 19; Cherry, 11; Gray Birch, 6; Thorn, 4; Hamamelis, 3; Hickory, 1; Hemlock 1; Elm, 2.

[2] *Intermixed species:* Pitch Pine, 3 from 6 to 10 inches diameter and under 60 feet high. *Populus grandidentata*, 1 over 6 inches diameter and under 60 feet high. Gray Birch, 6 from 6 to 10 inches diameter and under 60 feet high; 31 from 3 to 6 inches diameter and over 40 feet high. Poplar, 2 from 6 to 10 inches diameter and under 60 feet high. Hemlock, 1 over 3 inches diameter and under 40 feet high. Young White Pine, 90.
Undergrowth: Oak, 53; Gray Birch, 1, and a few small Cherry, not counted.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

C.—MASSACHUSETTS—Continued.

(9) SITE *i*: Northbridge, Worcester County. Sample area: 1 acre.

[500 feet above sea level.]

Soil: Yellow sandy loam, fine grain, deep, fresh, well drained, with about 4 inches mold on top, and a moderately leafy surface cover; subsoil, probably ledge rock. Age of pine: 35 years. Density of crown cover: 0.8.
Forest conditions: White Pine, with occasional Birch and Maple, on a hill; undergrowth, moderately dense, of Oak, Maple, and Chestnut.[1] Number of trees: 413.

ACRE YIELD.

White Pine.				
			Volume.	
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
284	8	50	2,556	
53	10	70	1,007	
36	11	70	792	
20	12	70	520	
11	13	70	341	
7	14	70	245	
2	15	70	80	
413 trees: Total cubic feet			5,540	

Average annual accretion: White Pine, 158 cubic feet.

(10) SITE *j*: Brookfield, Worcester County. Sample area: 1 acre.

[800 to 900 feet above sea level.]

Soil: Dark brown or black loam, fine grain, light, deep, fresh, well drained, with about 2 inches mold on top and a moderately leafy surface cover; subsoil, rock not far below surface. Age of pine: 35 to 40 years. Density of crown cover: 0.8.
Forest conditions: White Pine, with occasional Pitch Pine and hardwoods on north slope of uneven land; undergrowth dense, of various hardwoods, with Oak and Chestnut predominating.[2] Number of trees: 303.

ACRE YIELD.

White Pine.				
			Volume.	
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
165	8	55	1,485	
43	9	55	516	
1	10	55	15	
33	10	60	528	
25	11	60	475	
14	12	60	322	
14	13	60	364	
7	14	65	231	
1	15	65	37	
303 trees: Total cubic feet			3,973	

Average annual accretion: White Pine, 104 cubic feet.

[1] *Intermixed species:* White Maple, 1 over 6 inches diameter and under 60 feet high; 2 from 3 to 6 inches diameter and over 40 feet high. Maple, 2 from 10 to 14 inches diameter and under 80 feet high; 8 from 3 to 6 inches diameter and over 40 feet high; 1 over 3 inches diameter and under 40 feet high. Apple, 1 over 3 inches diameter and over 40 feet high. Young White Pine, 77.
Undergrowth: Oak, 152 (and numerous small trees); Chestnut, 52; Gray Birch, 1; Maple, 12 (and numerous small trees); White Maple, 3.

[2] *Intermixed species:* Pitch Pine, 2 from 10 to 14 inches diameter and under 80 feet high; 5 from 6 to 10 inches diameter and under 60 feet high. Oak, 1 over 6 inches diameter and under 60 feet high; 1 over 3 inches diameter and over 40 feet high; 1 over 3 inches diameter and under 40 feet high. Gray Birch, 21 from 3 to 6 inches diameter and over 40 feet high; 4 from 3 to 6 inches diameter and under 40 feet high. White Birch, 1 over 3 inches diameter and over 40 feet high. Maple, 1 over 6 inches diameter and under 60 feet high; 1 over 3 inches diameter and under 40 feet high. Chestnut, 1 over 10 inches diameter and under 80 feet high; 1 over 3 inches diameter and under 40 feet high. Poplar, 1 over 10 inches diameter and under 80 feet high. Young White Pine, 89.
Undergrowth: Oak, 404; Chestnut, 188; Maple (Red and White), 93; Black Birch, 27; Hemlock, 7; Ash, 30; Gray Birch, 32; Cherry (and numerous small trees), 1. Numerous small Poplars not counted.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

C.—MASSACHUSETTS—Continued.

(11) SITE *k*. Charlton, Worcester County. Sample area, 1 acre.

[About 800 feet above sea level.]

Soil.—Dark brown sandy loam, medium grain, loose, deep, fresh, well drained, with about 2 inches mold on top, and a moderately leafy surface cover; subsoil, rock and sand. Age of pine, 48 years.
Forest conditions.—White Pine, nearly pure, with 18 young trees on a hill; undergrowth scanty, of Chestnut, Maple, Oak, and Cherry. Density of crown cover, 0.6.
Number of trees: 446.

ACRE YIELD.

White Pine.				
			Volume.	
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
277	8	60	2,770	
62	10	70	1,178	
50	11	70	1,100	
29	12	70	754	
13	13	70	403	
9	14	70	315	
3	15	70	120	
3	16	70	135	
446 trees: Total cubic feet			6,775	

Average annual accretion.—White Pine, 141 cubic feet.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

SITE *b*.

Tree number.	Age.	Diameter (breast high).	Height.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Average annual accretion.
	Years.	*Inches.*	*Feet.*	*Cu. ft.*			*Cu. ft.*
1	52.0	13.0	71.5	31.7	0.47	0.47	0.61
2	50.0	9.0	60.0	13.8	.52	.22	.28
3	48.0	9.2	62.5	15.6	.54	.36	.32
Average	50.0	10.4	65.0	20.4	.51	.35	.40

SITE *c*.

4	54.0	11.3	59.0	19.7	0.48	0.37	0.36
5	52.0	13.8	71.5	36.3	.49	.42	.70
6	50.0	9.5	64.0	16.3	.52	.28	.33
Average	52.0	11.5	65.0	27.4	.50	.36	.46

SITE *e*.

7	39.0	8.3	52.0	8.8	0.45	0.40	0.22
8	39.0	9.2	58.0	13.0	.49	.36	.33
9	39.0	12.0	59.0	22.4	.48	.50	.57
Average	39.0	9.8	56.0	14.7	.47	.42	.37

SITE *i*.

19	40.0	9.5	55.0	14.3	0.53	0.42	0.36
20	36.0	11.2	53.0	18.4	.51	.55	.51
21	33.0	6.5	51.0	6.7	.57	.37	.20
Average	36.3	9.0	53.0	13.1	.54	.45	.36

SITE *j*.

22	37.0	10.5	53.0	16.4	0.51	0.45	0.44
23	39.0	9.3	55.0	13.8	.54	.44	.35
24	39.0	7.0	52.0	7.9	.56	.37	.20
Average	38.3	8.9	53.0	12.7	.54	.42	.33

SITE *k*.

25	48.0	10.0	63.0	17.0	0.50	0.26	0.35
26	48.0	12.8	69.5	33.0	.53	.38	.69
27	48.0	9.1	61.0	16.0	.54	.40	.33
Average	48.0	10.6	65.5	22.0	.52	.35	.46

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

D.—NEW HAMPSHIRE:

(1) SITE *l*: Boscawen, Merrimack County. Sample area: 1 acre.

[300 feet above sea level.]

Soil: Dark-brown loamy sand, coarse grain, porous, loose, shallow, dry, well drained, with 1 inch mold on top and moderately leafy surface cover; subsoil, yellow sand. Age of pine: 40 years. Density of crown cover: (?)

Forest conditions: White Pine, with scattering Red Pine on somewhat uneven land, which slopes east to the Merrimack River and falls off west to bordering run; undergrowth of few Hemlock and small White Pine.[1] Number of trees: 1,077.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
150	Under 3	20	.....	
619	3 to 6	40	.....	
195	6 to 8	50	1,365	
65	8 to 10	50	715	
30	10	50	390	
7	11	50	112	
4	12	50	76	
5	13	50	110	
1	14	50	25	
1	16	50	39	
1,077 trees: Total cubic feet			2,832	

Average annual accretion: White Pine, 71 cubic feet.

(2) SITE *m*: Franklin, Merrimack County. Sample area: 1 acre.

[900 to 1,000 feet above sea level.]

Soil: Brown sandy loam, medium grain, compact, moist, well drained, with 1 to 3 inches mold on top and moderately leafy surface cover; subsoil, rock. Age of pine: 40 to 45 years. Density of crown cover: 0.9.

Forest conditions: White Pine intermixed with Maple and Birch, on a hill; undergrowth, moderately dense, of young Maple, Birch, and other scattering hardwoods.[2] Number of trees: 410.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet*	*Cubic feet.*	*Feet B. M.*
298	8	60	2,980	
7	9	60	91	
47	10	70	893	
38	11	70	836	
9	12	70	234	
7	13	70	217	
2	14	70	70	
1	15	70	40	
1	16	70	45	
410 trees: Total cubic feet			5,406	

Average annual accretion: White Pine, 120 cubic feet.

[1] *Intermixed species:* Red Pine, 1 over 10 inches diameter and under 40 feet high; 2 from 8 to 10 inches diameter and under 40 feet high; 4 from 6 to 8 inches diameter and over 40 feet high; 4 from 6 to 8 inches diameter and under 40 feet high; 5 from 3 to 6 inches diameter and over 40 feet high; 13 from 3 to 6 inches diameter and under 40 feet high. Red Pine, 1 over 8 inches diameter and over 40 feet high; 1 over 3 inches diameter and over 40 feet high; 1 over 3 inches diameter and under 40 feet high.

Undergrowth: Hemlock, 26; Gray Birch, 1.

[2] *Intermixed species:* Red Maple, 11 from 6 to 10 inches diameter and over 60 feet high; 6 from 6 to 10 inches diameter and under 60 feet high; 30 from 3 to 6 inches diameter and over 40 feet high; 3 from 3 to 6 inches diameter and under 40 feet high. White Birch, 7 from 10 to 14 inches diameter and under 80 feet high; 26 from 6 to 10 inches diameter and over 60 feet high; 29 from 3 to 6 inches diameter and over 40 feet high. Red Oak, 2 from 3 to 6 inches diameter and over 40 feet high. *Prunus serotina*, 1 over 6 inches diameter and under 60 feet high. Poplar, 2 from 6 to 10 inches diameter and over 60 feet high. Hemlock, 2 from 3 to 6 inches diameter and under 40 feet high. Chestnut, 1 over 6 inches diameter and over 60 feet high. Young White Pine, 119.

Undergrowth: Red Maple, 23; Cherry, 3; Hamamelis, 14; White Birch, 2; Hemlock, 4; Ash, 1. Poplar, 1.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

D.—NEW HAMPSHIRE—Continued.

(3) SITE *a*: Hopkinton, Merrimack County. Sample area: 1 acre.

[800 to 900 feet above sea level.]

Soil: Brown gray, or nearly black sandy loam, fine grain, moist, well drained, with mold on top and moderately leafy surface cover, subsoil, rock. Age of pine: 60 to 65 years. Density of crown cover: 0.8 to 0.9.

Forest conditions: White Pine, with occasional Red Pine, on a hill; undergrowth, moderately dense, of Hemlock and scattering hardwoods; on occasions dead and little suppressed trees cut out and trimming done.[1] Number of trees: 291.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
54	8	60	540	
43	10	70	817	
48	11	70	1,056	
36	12	70	936	
37	13	70	1,147	
27	14	70	945	
14	15	70	560	
14	16	70	630	
8	17	80	464	
3	18	80	192	
3	19	80	210	
1	20	80	77	
2	22	80	192	
1	23	80	104	
291 trees: Total cubic feet			7,870	

Average annual accretion—White Pine, 127 cubic feet.

(4) SITE *a*: Hopkinton, Merrimack County. Sample area: 1 acre.

[800 to 900 feet above sea level.]

Soil: Brown loam, fine grain, moderately loose, fresh, well drained, with 3 to 4 inches mold on top and leafy surface cover; subsoil, rocks not very far down. Age of pine: 35 to 40 years. Density of crown cover: 0.8.

Forest conditions: White Pine with occasional Red Pine on a north slope of hill; undergrowth, moderately dense, of Elm, Maple, Hemlock, and occasional hardwoods.[2] Number of trees: 435.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
63	3 to 6	40	.....	
189	6 to 10	50	1,701	
56	10	60	876	
52	11	60	988	
26	12	60	598	
27	13	60	702	
8	14	60	240	
11	15	65	418	
3	16	65	126	
435 trees: Total cubic feet			5,649	

Average annual accretion: White Pine, 148 cubic feet.

[1] *Intermixed species:* Red Pine, 6 from 10 to 14 inches diameter and under 80 feet high. Maple, 1 over 10 inches diameter and under 80 feet high.

Undergrowth: Hemlock, 98; Beech, 4.

[2] *Intermixed species:* Red Pine, 3 from 10 to 14 inches diameter and under 80 feet high. Maple, 2 from 3 to 6 inches diameter and over 40 feet high. White Birch, 1 over 3 inches diameter and over 40 feet high. Apple, 2 from 10 to 14 inches diameter and under 80 feet high. Hemlock, 3 from 3 to 6 inches diameter and under 40 feet high.

Undergrowth: Elm, 64. *Cornus alternifolia*, 1; Beech, 1; Hemlock, 36; Cherry, 2; Ash, 1; Hamamelis, 1. Maple 62, numerous small Maples; small Oaks.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

D.—NEW HAMPSHIRE—Continued.

(5) SITE *p*: Litchfield, Hillsboro County. Sample area: 1 acre.

[About 250 feet above sea level.]

Soil: Dark-brown sandy loam, fine grain, porous, light, loose, shallow, dry, well drained, with about 2 inches mold on top and moderately leafy surface cover; subsoil, yellowish fine sand with clay about 4 to 6 feet below surface.
Forest conditions: White Pine with scattering Pitch Pine on level plain; undergrowth scanty, of Maple, Birch, and few other hardwoods.[1]

Age of pine: 35 to 40 years.
Density of crown cover: 0.7 to 0.8.
Number of trees: 517.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
5	Under 3	20	.....	
182	3 to 6	40	.....	
233	6 to 10	50	2,097	
30	10	60	480	
19	11	60	361	
13	12	60	199	
10	13	60	260	
12	14	65	396	
6	15	65	222	
2	16	65	84	
2	17	70	102	
1	18	70	56	
1	19	70	61	
1	22	70	78	
517 trees: Total cubic feet			4,396	

Average annual accretion: White Pine, 15 cubic feet.

(6) SITE *q*: Hillsboro County. Sample area: 1 acre.

[About 700 feet above sea level.]

Soil: Brown loam, fine grain, deep, moist, well drained, with 2 to 4 inches mold on top and abundant leafy surface cover; subsoil, compact, clayey sand.
Forest conditions: White Pine with scattering Maple and Hemlock on hill; undergrowth dense, of Maple, Oak, Chestnut mainly, and few other scattering hardwoods.[2]

Age of pine: 40 to 45 years.
Density of crown cover: In clusters.
Number of trees: 371.

ACRE YIELD.

White Pine.				
Number of trees.	Diameter (breast high).	Height.	Volume.	
			Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
76	3 to 6	40	.....	
153	6 to 10	50	1,377	
36	10	60	576	
40	11	60	760	
31	12	60	713	
17	13	60	442	
8	14	60	240	
6	15	65	222	
3	16	65	126	
1	17	65	47	
371 trees: Total cubic feet.....			4,503	

Average annual accretion: White Pine, 107 cubic feet.

[1] *Intermixed species:* Gray Birch, 1 over 3 inches diameter and over 40 feet high; 1 over 3 inches diameter and under 40 feet high. Maple, 1 over 6 inches diameter and under 60 feet high; 1 over 3 inches diameter and over 40 feet high; 2 over 3 inches diameter and under 40 feet high. Pitch Pine, 1 over 10 inches diameter and over 80 feet high; 9 from 10 to 14 inches diameter and under 80 feet high.
Undergrowth: Maple, 9; Gray Birch, 8; Cherry, 1; Oak, 4; Spruce, 1; numerous small Oaks and Poplars

[2] *Intermixed species:* Hemlock, 12 from 6 to 10 inches diameter and under 60 feet high; 8 from 3 to 6 inches diameter and under 40 feet high. Maple, 1 over 10 inches diameter and under 80 feet high; 2 from 6 to 10 inches diameter and over 60 feet high; 21 from 6 to 10 inches diameter and under 60 feet high; 26 from 3 to 6 inches diameter and over 40 feet high; 11 from 3 to 6 inches diameter and under 40 feet high. White Oak, 5 from 3 to 6 inches diameter and over 40 feet high; 3 from 3 to 6 inches diameter and under 40 feet high. Cherry, 1 over 10 inches diameter and under 80 feet high; 1 over 6 inches diameter and under 60 feet high; 2 from 3 to 6 inches diameter and over 40 feet high
Undergrowth: Chestnut, 202; Cherry, 8; Maple, 492; Black Birch, 3; Ash, 21; White Oak, 229; Hemlock, 20; Elm, 9; Thorn 1.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

D. NEW HAMPSHIRE—Continued.

(7) SITE *r*. Milford, Hillsboro County. Sample area: 2 acres.

[300 to 400 feet above sea level.]

Acre No. 1.

Soil: Dark brown sandy loam, fine grain, shallow, dry, well drained, with 1 to 2 inches mold on top and surface cover of abundant leaves; subsoil, light colored and powdery, 6 to 10 inches deep, probably sandy lower down.

Forest conditions: White Pine on slope; undergrowth, dense, of Oak mixed with Maple, Chestnut and other scattering hardwoods.[1]

Age of pine: 35 to 40 years.
Density of crown cover: Full.
Number of trees: 794.

ACRE YIELD.

White Pine.				
			Volume.	
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
339	3 to 6	40	.....	
323	6 to 8	50	2,261	
108	8 to 10	50	1,188	
11	10	50	143	
9	11	50	141	
2	12	50	38	
2	13	50	44	
794 trees: Total cubic feet			3,818	

Average annual accretion: White Pine, 109 cubic feet.

Acre No. 2.

Age of pine: 35 to 40 years.

Soil: Brown sandy loam, medium grain, loose, fresh, 1 foot deep, with 2 inches mold on top and a moderately leafy surface cover.

Forest conditions: White Pine with scattering Maple on north slope of hill; undergrowth in parts moderately dense, of Ash, Maple, and few other hardwoods, and in denser parts very little undergrowth.[2]

Density of crown cover: 0.6 to 0.7.
Number of trees: 503.

ACRE YIELD.

White Pine.				
			Volume.	
Number of trees.	Diameter (breast high).	Height.	Bole.	Merchantable timber.
	Inches.	*Feet.*	*Cubic feet.*	*Feet B. M.*
151	3 to 6	40	.....	
236	6 to 10	50	2,124	
14	10	55	660	
21	11	55	378	
17	12	55	357	
10	13	55	240	
11	14	60	330	
5	15	60	175	
3	16	60	117	
2	17	60	86	
1	19	60	57	
1	20	70	72	
1	21	70	78	
503 trees: Total cubic feet			4,674	

Average annual accretion: White Pine, 123 cubic feet.

[1] *Intermixed species:* Oak, 1 over 10 inches diameter and over 50 feet high; 1 over 8 inches diameter and under 50 feet high; 3 from 3 to 6 inches diameter and over 40 feet high.

Undergrowth: Oak, 381; Maple, 61; Chestnut, 41; Gray Birch, 4; Yellow Birch, 1; Hemlock, 1; Cherry, 14, with numerous small trees.

[2] *Intermixed species:* Maple, 1 over 10 inches diameter and under 80 feet high; 5 from 6 to 10 inches diameter and under 60 feet high; 4 from 3 to 6 inches diameter and over 40 feet high; 2 from 3 to 6 inches diameter and under 40 feet high. Cherry, 1 over 6 inches diameter and under 60 feet high; 2 from 3 to 6 inches diameter and under 40 feet high. Apple, 1 over 6 inches diameter and under 60 feet high; 1 over 3 inches diameter and under 40 feet high. Pitch Pine, 2 from 6 to 10 inches diameter and under 60 feet high. White Birch, 1 over 6 inches diameter and over 60 feet high.

Undergrowth: Ash, 45; Maple, 8; Cherry, 3; Oak, 5; Hamamelis, 10; Chestnut, 1; Elm, 2.

TABLE VII.—*Acre yields of second-growth White Pine, with measurements of young pine taken for analysis*—Continued.

D.—NEW HAMPSHIRE—Continued.

MEASUREMENTS OF SAMPLE YOUNG PINE TREES.

Age class. Under 50 years.

SITE *l*.

Tree number.	Age.	Diameter (breast high).	Height.	Rings per inch on stump.	Volume of tree.	Factor of shape.	Ratio of length of crown to total height of tree.	Current annual accretion.		Average annual accretion.
	Years.	*Inches.*	*Feet.*	*No.*	*Cubic ft*			*Per cent.*	*Cubic ft.*	*Cubic ft.*
28	41	6.8	44	.....	5.6	0.51	0.43	.....	.....	0.30
29	41	7.1	52	.....	8.0	.56	.51	.....	.....	.20
30	41	8.2	55	.....	10.0	.51	.51	.....	.....	.24
Average...	41	7.4	50	.....	7.9	.53	.48	.....	.....	.25

SITE *m*.

31	42	9.7	63	.....	16	0.50	0.38	.....	.....	0.38
32	42	10.4	70	.....	21.3	.51	.34	.....	.....	.51
33	42	8.7	65	.....	13.1	.49	.34	.....	.....	.31
Average...	42	9.6	66	.....	16.8	.50	.35	.....	.....	.40

SITE *o*.

35	38	9.3	57.5	.....	13.8	0.51	0.39	.....	.....	0.36
36	39	10.3	62.5	.....	18.0	.50	.40	.....	.....	.46
Average...	38.5	9.8	60	.....	15.9	.50	.39	.....	.....	.41

SITE *r*.

1	81	17	73	4	48.2	0.42	0.53	4.6	2.22	0.59
2	77	17	74	4	52.4	.44	.55	3.0	1.57	.68
Average...	79	17	73.5	4	50.3	.43	.54	3.8	1.89	.63

SCHEDULES AND SAMPLE RECORDS.

SCHEDULES AND SAMPLE RECORDS.

FORMS USED IN THE INVESTIGATION.

FORM NO. 1.

United States Department of Agriculture.
DIVISION OF FORESTRY.

RECORDS OF TREE MEASUREMENTS.

Name of collector: N.
Species: White Pine.
Year: 1897.

GENERAL DESCRIPTION OF STATION.

[Denoted by capital letter.]

State: Pennsylvania. County: Clearfield. Town: Dubois.

Longitude: 78° 45′. Latitude: 41° 3′. Altitude: 1,200 to 1,500 feet.

General configuration: Plains hills plateau *mountainous.*

General trend of valleys or hills: (Not noted.)

Climatic features: (Meteorological tables furnished.)

General forest conditions of the region: This region in 1876 extended over 20,000 acres. The lumber operation carried on for twenty years by Mr. Du Bois left for the present only from 1,500 to 2,000 acres standing timber in a primeval condition.

Three typical forms of forest conditions are suggested to the observer:

(1) Hemlock and White Pine forest, with an admixture of mature hardwoods and a number of young hardwoods and young Hemlock, which form the undergrowth.

(2) Hemlock mixed with White Pine, with scattering hardwoods; the undergrowth usually moderately dense, consists mainly of young Hemlock with the admixture of young hardwoods.

(3) Hardwoods intermixed with White Pine and scattering Hemlock. The undergrowth here consists mainly of young hardwoods.

Among the hardwoods, the Oak, Birch, and Maple form the staple of the hardwood forest, while the Beech, Chestnut, Hickory, Cucumber, Ash, Cherry, and Basswood are comparatively few in number. The region has a uniform soil and subsoil as it may be judged by the sample areas NN. 5, 6, and 7, and is well provided with moisture by the many streams crossing it all over in different directions.

FORM NO. 2.

DESCRIPTION OF SITE.

[Denoted by small letter.]

Sample area, No. 5: (One acre.)

Conformation of surface: Hill sloping toward southwest, where it is bordered by the left-hand branch of Irish Narrow Creek.

Soil and drainage conditions: Yellow clay loam of a medium grain (fine shale in it), deep, fresh, well drained, with 2 to 3 inches mold on top.

Subsoil: Laminated shale of an indefinite depth.

Soil cover: Scanty leaves, fern, and teaberries.

Origin of stand: Natural regeneration.

Form: Uniform; storied. White Pine forms first and Hemlock the second.

Composition: A stand of Hemlock mixed with White Pine, intermixed with scattering Maple, Beech, and Birch.

Undergrowth: Absent; dense; moderately dense; scanty; consists of very young Beech, Hemlock, and occasional Birch, Cucumber, and Dogwood (Laurel in northeast corner).

Density of stand: 0.7 (in places 0.8).

REMARKS.—Crowns of White Pine generally well developed; clear and straight stems. Age of White Pine 230 to 260 years. Age of Hemlock almost the same as that of White Pine.

ACRE-YIELD MEASUREMENTS.

Diameter at breast height (in inches).	Name of species.															Undergrowth.		
	White Pine.			Hemlock.			Maple.			Beech.			Birch.				Diameter (breast high).	
	Dominant height from 140 to 160 feet.	Codominant height from 100 to 140.	Oppressed height from 80 to 100.	Dominant height from 90 to 120.	Codominant height from 80 to 120.	Oppressed height from 60 to 80.	Dominant height from 80 to 100.	Codominant height from 60 to 80.	Oppressed height from 40 to 60.	Dominant height from 80 to 100.	Codominant height from 60 to 80.	Oppressed height from 40 to 60.	Dominant height from 80 to 100.	Codominant height from 60 to 80.	Oppressed height from 40 to 60.	Name of species.	3-6 inches.	Under 3 inches.
6																Hemlock.		29
7						//////////	/											36
8													/					43
9						///	/											37
10						//												34
11													/					11
12						////							/					47
13										//								38
14						///										Maple.		31
15						////	/											42
16			/			/	/											38
17					///	////												
18				/	////													
19			/	////	//					/								
20			/	//	////	/												
21				/	//											Beech.		
22				///	////													
23		/	/	///														10
24																		
25		////																
26		/																4
27				////												Birch.		
28		/ /		/														
29		/		/														
30		/		/														
31	/																	
32	/																	
33	//																	
34	/ /																	
35																Cucumber.		
36	/																	
37																		
38																		
39																		
40																		
41																		
42																		
43																		
44	/																	
45																		

DEDUCED RESULTS.

Total number of trees on the acre: 132, of which there were—

First species: White Pine, 37; dominant, 41 per cent; codominant, 48 per cent; oppressed, 11 per cent.

Second: Hemlock, 81; dominant, 32 per cent; codominant, 26 per cent; oppressed, 42 per cent.

Third: Maple, 5.

Fourth: Beech, 3.

Fifth: Birch, 3.

Total yield of the acre: Volume of stems, 15,686 cubic feet; merchantable timber, 90,103 feet B. M.

Of which there were—

First species: White Pine, 58 per cent of total yield.

Second species: Hemlock, 42 per cent of total yield.

Third, fourth, and fifth species: Hemlock not taken into consideration.

Average annual accretion: In cubic feet, 65; merchantable timber, in feet B. M., 375.

FORM NO. 3.

MEASUREMENTS OF SAMPLE TREES.

SITE: *f*. SPECIES: White Pine.

Tree No.	Diameter (in inches) at a height (in feet) from ground of—																	Height to base of crown.	Total height of tree.	Character of growth.			Merchantable timber (feet B.M.).	Condition of timber.						Position and surrounding species.	Remarks.
	Breast height.	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128			Dominant.	Codominant.	Oppressed.		Sound.	Defective.	Crooked.	Clear.	Knotty.	Windshaken.		
1	35½	34	29	28	28	27	26½	26	25	24	23	22	20	19	16½	13	11	90	158	×			3,030	×						White Pine, Hemlock, and small Beech.	
2	36	33	31	30	29	28	28	27	26	26	25	23	21½	19½	18	15	13	90	157	×			3,401	×						Hemlock, Pine, Birch, Maple, and Ash.	
3	32	30	28	28	27	25½	25	24½	24½	23½	23½	21½	19½	18	15½	12½	....	84	152	×			2,637							Hemlock and Pine.	
4	32	30	27½	26	26	25	24	23½	22½	21½	20½	18½	17½	15	12½	10½	8	62	150	×			2,079							do	
5	29	27½	26	25	25	24	23	22	21½	21	18½	17	15½	14	11½	8	6	100	140		×		1,905	×						do	Crowded.
6	29	26½	25½	24½	23½	23	22½	21½	20	20	19	17½	16	15	13	9	7	110	140		×		1,631	×						do	Do.
7	29	27½	25½	24½	23½	23	21½	21	21	19½	19	18	16½	15½	14	12½	9½	112	152		×		1,854	×						do	Do.
8	29	26	23½	22½	22	21	20	19	18½	18½	17	16½	14½	13	11	8	6	86	142		×		1,313	Core at butt.						do	Do.
9	32	28½	25½	24½	23½	23	22	21	21	18½	18	16½	15	14	11	8	7	84	142		×		1,648	do						do	Crown free.
10	33	30½	29	27½	26½	25½	25	24	23	21½	21	19	18	15½	13½	12½	8	96	146	×			2,384	×						do	Somewhat crowded.
11	30	28½	27	25	24½	24	23	22½	20½	19½	18½	17½	16½	13½	11½	9	6	81	141		×		1,947							do	
12	28	27	24½	24	23	23	22	21	20½	19½	19	17	16	13½	12	9½	8	88	156	×			1,648							do	Crowded.
13	23	20½	20½	20½	20½	19½	19	18½	17	16½	15	15	14	12½	11½	9½	7½	93	141		×		1,048							do	Do.
14	25	23½	22½	22	21	20½	19½	18½	18	17½	16	14½	13	11½	9	6½	....	98	139		×		1,233	Core at butt.						do	
15	26	24½	23½	22½	21½	21	21	20½	20½	18½	17½	17	16	14	12½	10	7	98	136		×		1,389	do						do	Top killed; somewhat crowded.
16	24½	21½	19½	19	18½	17½	17	16½	16	14½	14	12	10½	8	4½	....	....	93	124		×		815	do						do	Crowded.
17	25	23½	22	21	20	20	19	19	18	17½	16½	15	14	12½	8½	....	....	108	128		×		1,183	do						do	Do.
18	39	36	33	32½	30	29½	28½	28	26	26	24	22½	21½	18½	18	14½	11½	88	153	×			3,318							do	At 134 feet top lost; free crown about 16 feet.
19	34	32	30	29	28	27½	26½	25	24½	23	22	19½	18	16½	13½	10½	8	78	134				2,397							do	
20	44	39	38	36½	35½	34	32½	31½	30½	28	27	26	23	21½	20	14½	10½	100	144	×			4,388							do	Crown free.
21	34	31½	28	27	26½	25½	24½	23½	22½	21½	21	19½	18	16½	14½	11½	8	92	146	×			2,248							do	Crown free; sound.
22	31	29	27	27	25	24	23	23	21	19½	19½	17	14½	12	9½	....	....	82	130		×		1,731	×						do	Crown somewhat crowded.
23	34	31½	29	28	27	25½	25	24	23½	22	20½	20½	18	16½	13½	9½	6	90	142	×			2,318	×						do	Crown free.
24	25	24½	22	21	20	19	18½	17½	16½	15	14	13	12	10	7	....	....	84	130		×		1,102	×						do	Somewhat crowded.
25	28½	26½	25½	24½	24½	24	22½	21½	21	20½	19	18	16	15½	13	11	5	107	138		×		1,934	×						do	Do.
26	26	24	21½	21	20½	19	18	17	16½	16	15	14	12½	11½	9	6	....	98	136		×		1,021							do	
27	19	18	17½	17½	16½	16	15½	15	14	14	13	12	11½	9½	8½	6½	....	94	132				683							do	Crown very crowded.
28	28½	26	24	23	22½	22	21½	21	20	19	18	17	15	13½	10½	7	...	75	138		×	1	1,551							do	
30	26½	24½	23	22½	21	20½	20	19½	19½	18	16½	15	13	11	9	6	....	90	134		×		1,336	Core at butt.						do	Somewhat crowded.
33	33	30	27½	25½	25½	24½	23	22	21	20	18	16	13½	12½	9	5½	....	91	133	×			1,770							do	Free exposure.
34	33	30	27½	27	26	25	25	24½	23½	22½	21	20	19	15½	15½	12	9	90	146	×			2,220							do	Do.
35	31	27	24½	23½	23	22½	21½	20½	20	19½	19	16½	14½	13	11	8	5½	82	136	×			1,458							do	Top about 8 feet not found.
36	31½	28½	26½	26	25	24	24	23½	21½	21	19	16½	15	12	10	7½	....	88	134	×			1,855	×						do	Do.
37	37	35	32½	32	31	30	28½	28	26½	26	23½	22½	21½	17	14	11½	8	106	146	×			2,970							do	Do.
38	23	22	21½	20	19½	19	18	17½	17	16	15	14	12½	11	9	5	....	90	137			×	987	×						do	Crown very crowded.
39	20½	18½	18	17½	17	16	15	14½	13½	12½	12	11½	10½	9½	5	....	....	109	123			×	558							do	Do.
40	16½	16	15½	15	14	13½	13	12	12	11	10	8½	7½	4½	....	....	....	82	120			×	339							do	Crown very small.

FORM NO. 4.

MEASUREMENTS OF DIAMETER DEVELOPMENT.

SECTION: Stump.

SITE *f*. AGE CLASS: ———. SPECIES: White Pine.

Tree No.	Height from ground	Thickness of bark.	Sap-wood. Number of rings.	Sap-wood. Width.	Number of rings.	Radius at age of— 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	Entire radius.	Remarks.
	mm			*mm*																																	
1	48	36	36	254	38	80	105	125	139	157	179	198	218	244	273	292	306	320	329	336	341	348	359	367	376	385	395	406	410	.....	.....		.....	.....	415	
2	35	33	37	254	24	54	71	85	96	109	130	163	180	213	235	250	281	308	325	336	346	364	386	397	408	418	429	444	452	.....	.....		.....	.....	454	
3	55	33	35	253	34	72	98	119	135	156	177	192	209	228	250	267	283	300	312	319	326	335	343	351	363	375	388	389	400	.....	.....		.....	.....	405	
4	35	20	25	235	25	59	107	133	178	200	221	256	276	304	313	330	346	357	369	377	388	398	407	417	426	435	442	...	.....	.....	.....		.....	.....	447	
10	40	47	30	238	38	78	116	145	180	205	244	248	257	276	295	309	322	333	350	362	370	389	398	408	415	422	430	...	.....	.....	.....		.....	.....	434	
12	30	45	28	256	32	61	80	99	121	138	158	178	186	200	214	229	240	253	268	275	284	294	303	310	319	329	334	339	345	.....	.....		.....	.....	350	
18	50	28	38	279	24	46	74	102	121	142	175	201	223	246	268	295	321	349	375	391	409	426	441	457	464	481	498	513	528	.....	.....		.....	.....	541	
19	50	35	50	244	27	53	75	103	129	154	182	199	212	232	250	263	282	303	311	322	336	349	364	392	417	432	453	472	.....	.....	.....		.....	.....	477	
20	50	30	18	260	37	89	133	165	200	251	292	345	372	392	409	426	444	461	477	488	509	509	516	525	537	547	541	561	567	571	.. .		.....	.....	.....	
21	40	37	30	239	25	58	82	102	121	139	158	175	186	203	225	245	270	291	315	334	347	359	369	378	385	395	406	...	.....	.....	.....		.....	.....	416	
23	49	24	22	242	19	53	77	99	120	144	167	190	210	244	257	271	288	302	311	324	342	353	359	366	374	383	413	420	.....	.....	.....		.....	.....	421	
36	25	35	45	235	26	56	77	92	109	120	130	138	150	180	200	222	246	265	278	292	305	318	331	350	378	388	406	...	.....	.....	.....		.....	.....	415	
34	40	46	35	256	23	60	97	133	160	187	222	261	275	290	302	316	328	336	348	357	367	376	382	390	398	408	415	423	429	.....	.....		.....	.....	432	
33	48	33	25	253	27	57	85	116	141	168	191	220	229	241	251	265	282	293	307	319	330	342	349	358	369	378	385	390	395	.....	.....		.....	.....	397	
35	50	41	28	257	34	74	110	138	161	182	209	222	229	237	246	255	265	276	289	293	304	318	329	338	345	352	358	365	373	.....	.....		.....	.....	378	
37	30	46	27	255	28	76	106	152	178	203	234	267	283	303	323	341	356	370	386	398	411	422	432	439	445	452	458	466	473	.....	.....		.....	.....	476	
28	39	48	28	256	36	72	104	135	160	178	195	207	211	218	225	237	251	262	270	274	279	285	289	293	298	306	312	320	325	...	....		.....	.....	328	
25	40	38	35	238	15	41	58	71	89	104	114	133	153	173	198	220	237	249	261	276	289	303	319	335	350	365	375	.....	.....	.....	.....		.....	.....	381	
24	37	25	25	239	15	45	73	94	110	123	131	136	140	146	155	165	173	181	189	197	208	218	237	255	277	298	314	...	.....	.....	.....		.....	.....	320	
22	40	43	30	240	32	71	111	137	156	195	218	241	254	263	275	293	306	316	324	332	343	356	365	375	385	390	407	412	.....	.....	.....		.....	.....	.....	
5	45	35	25	258	26	54	70	86	104	120	140	156	168	178	191	204	219	238	251	263	277	294	309	324	337	347	356	363	371	.....	.....		..	.....	382	
6	40	28	25	258	23	71	102	122	146	166	183	202	218	227	239	253	264	276	286	293	299	306	318	327	338	349	358	365	372	.....	.....		.....	.....	377	
7	30	35	24	256	25	53	92	114	128	141	155	167	177	189	201	225	236	244	255	263	269	278	287	295	302	312	319	323	334	.....	.....		.....	.....	337	
8	.....	.....	.....	229							Core for 3 inches.																										
9	.....	.....	.....	230							Core for 3 inches.																										
11	32	29	37	238	31	55	69	87	105	121	132	147	166	183	199	221	247	258	270	284	300	314	327	342	357	371	384	.....	.....	.....	.....		.....	.....	396	
13	42	32	20	252	20	61	94	114	131	144	158	172	185	199	214	226	236	246	255	264	272	282	290	295	300	309	316	321	326	.....	.....		.....	.....	327	
14	.....	.....	.....	206							Core for 4½ inches.																										
15	.....	.....	.....	258							Core for 5 inches.																										
16	.....	.....	.....	229							Core for 3 inches.																										
17	.....	.....	.....	256							Core for 6 inches.																										
26	27	29	40	239	25	60	81	91	112	121	125	132	145	150	161	176	184	193	200	211	222	234	247	266	281	295	310	.....	.....	.....	.....		.....	.....	321	
30	27	40	42	253	28	58	80	102	121	143	162	175	182	193	205	217	229	240	252	262	272	281	289	297	303	309	312	320	326	.....	.....		.....	.....	329	
27	20	45	24	253	30	66	89	106	125	141	158	173	178	183	187	193	203	209	217	224	231	236	239	242	246	252	259	264	270	.....	.....		.....	.....	271½	
38	38	47	29	254	35	73	97	119	137	152	165	176	185	192	201	210	221	231	237	244	250	256	261	264	269	273	277	281	284	.....	.....		.....	.....	285	
39	32	54	24	252	37	81	102	122	127	148	156	163	167	170	176	183	191	196	200	203	205	208	214	220	226	230	235	238	241	.....	.....		.....	.....	241½	
40	22	35	16	255	29	64	81	101	117	131	141	151	155	158	162	170	177	183	186	191	195	200	205	208	211	215	221	225	229	.....	.....		.....	.....	232	

Codominant. Dominant. Oppressed.

FORM NO. 4—Continued.

SECTION No. 3.

SITE *f*. AGE CLASS: ———. SPECIES: White Pine.

Tree No.	Height from ground.	Thickness of bark.	Sapwood. Number of rings.	Sapwood. Width.	Number of rings.	Radius at age of— 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	Entire radius.	Remarks.
	mm			*mm*																																	
1	50	15	49	32	221	50	76	98	115	130	143	156	180	193	205	214	224	230	235	242	249	256	262	269	275	282	287	....	....	....		....	....	....	....	288	
2	50	17	45	35	214	35	64	84	102	118	135	153	169	195	201	219	231	242	253	265	277	288	297	307	317	324	....	....	....	....		....	....	....	....	327	
3	50	17	47	42	227	33	72	97	112	127	138	150	164	176	185	196	204	210	217	226	234	243	253	263	272	280	288	....	....	....		....	....	....	....	293	
4	50	11	50	30	208	40	74	107	129	148	162	175	188	200	210	219	228	237	245	253	258	266	272	278	282	....	....	....	....	....		....	....	....	....	286	
10	50	14	50	30	210	42	80	110	130	144	158	172	185	196	205	217	225	234	245	253	259	265	272	278	283	293	....	....	....	....		....	....	....	....	....	
12	50	12	55	32	228	26	76	95	116	130	142	155	169	178	189	198	205	209	214	219	225	230	235	241	247	252	258	....	....	....		....	....	....	....	264	
18	50	19	41	40	223	35	64	86	106	125	139	157	176	195	213	228	243	257	263	275	288	292	306	318	328	337	346	....	....	....		....	....	....	....	349	
19	50	20	39	38	209	40	67	90	106	120	132	146	165	180	194	207	217	230	241	253	265	279	290	302	311	....	....	....	....	....		....	....	....	....	317	
20	50	20	50	30	219	68	123	164	193	212	231	246	262	278	288	297	306	313	320	327	334	340	347	355	362	368	....	....	....	....		....	....	....	....	371	
21	50	16	40	34	202	33	69	91	108	120	132	147	163	176	189	201	211	221	231	241	249	258	268	276	284	....	....	....	....	....		....	....	....	....	286	
23	50	15	40	40	204	20	61	91	109	122	134	148	163	177	190	200	212	223	233	242	250	259	270	280	295	....	....	....	....	....		....	....	....	....	300	
36	50	15	45	38	202	25	37	53	67	78	96	115	134	150	167	178	190	201	211	221	228	236	245	253	261	....	....	....	....	....		....	....	....	....	263	
34	50	15	41	30	223	45	82	110	135	153	164	177	190	200	210	216	225	234	242	248	256	265	276	283	290	298	304	....	....	....		....	....	....	....	307	
33	50	15	48	30	223	48	78	103	121	142	149	158	167	174	183	187	196	204	213	218	223	231	238	243	248	254	258	....	....	....		....	....	....	....	260	
35	50	15	47	20	226	47	84	114	135	148	155	161	168	176	183	190	198	204	210	217	222	228	233	239	242	247	251	....	....	....		....	....	....	....	254	
37	50	12	44	30	217	51	103	145	173	195	214	229	232	244	253	261	269	277	289	295	302	309	314	321	328	331	....	....	....	....		....	....	....	....	340	
28	50	12	63	29	228	44	81	109	127	142	153	160	167	175	184	195	204	208	214	220	225	230	235	240	243	248	253	....	....	....		....	....	....	....	257	
25	50	15	50	40	188	38	69	92	117	133	156	172	184	194	204	215	226	238	245	253	261	268	278	....	....	....	....	....	....	....		....	....	....	....	284	
24	50	12	26	25	193	13	18	25	33	53	75	89	101	111	118	126	137	147	160	173	188	202	214	220	....	....	....	....	....	....		....	....	....	....	221	
32	50	15	43	27	203	34	74	107	129	148	161	174	187	197	208	216	224	230	235	241	247	254	260	266	271	....	....	....	....	....		....	....	....	....	273	
17	50	15	50	30	226	27	64	88	104	117	128	137	146	155	164	169	173	175	178	182	186	192	198	205	212	217	223	....	....	....		....	....	....	....	226	
5	50	15	43	33	220	34	66	83	97	107	116	125	136	148	159	170	182	193	213	212	225	233	241	250	258	265	272	....	....	....		....	....	....	....	....	
6	50	17	45	30	222	40	72	93	108	119	128	137	148	159	170	180	190	200	207	215	221	229	236	242	250	255	261	....	....	....		....	....	....	....	262	
7	48	13	50	30	222	40	73	93	107	120	130	140	150	160	170	180	187	197	205	214	222	229	237	244	250	255	260	....	....	....		....	....	....	....	263	
8	50	16	45	35	188	22	46	52	75	87	102	116	129	140	151	164	172	180	189	198	207	214	221	....	....	....	....	....	....	....		....	....	....	....	226	
9	50	15	42	35	192	35	58	78	96	113	131	150	162	177	189	198	208	214	230	241	250	257	264	273	....	....	....	....	....	....		....	....	....	....	275	
11	50	20	44	44	200	37	62	78	89	102	113	127	141	156	166	176	187	200	214	226	239	249	259	262	270	....	....	....	....	....		....	....	....	....	....	
13	50	12	53	33	223	31	57	74	90	99	110	119	128	135	142	149	155	162	168	174	181	188	195	201	208	215	221	....	....	....		....	....	....	....	223	
14	50	12	34	35	204	30	50	66	69	76	84	93	102	112	123	130	137	145	156	167	176	186	196	205	216	....	....	....	....	....		....	....	....	....	220	
15	50	15	39	39	219	35	62	78	88	100	107	115	123	134	142	151	158	164	172	180	189	198	209	217	228	239	....	....	....	....		....	....	....	....	248	
16	50	15	45	37	185	27	55	72	85	100	112	122	132	140	148	153	161	169	179	186	195	204	211	....	....	....	....	....	....	....		....	....	....	....	216	
26	50	10	35	35	194	21	46	65	83	89	97	107	117	123	129	137	146	155	168	179	180	199	210	220	....	....	....	....	....	....		....	....	....	....	223	
30	48	10	51	30	220	38	71	98	114	125	134	141	150	161	171	179	187	192	198	203	210	215	220	225	233	239	244	....	....	....		....	....	....	....	....	
27	50	11	40	19	223	43	71	89	103	113	117	120	122	125	129	133	138	143	148	150	152	156	160	163	167	171	174	....	....	....		....	....	....	....	175½	
38	50	10	53	19	223	46	69	98	111	121	129	136	145	153	160	166	172	178	183	188	192	196	201	204	207	210	212	....	....	....		....	....	....	....	213	
39	50	12	52	19	226	30	66	86	99	108	113	116	120	127	134	139	143	146	148	151	155	160	165	169	173	176	179	....	....	....		....	....	....	....	181	
40	56	10	52	19	222	30	55	70	79	84	89	94	99	105	109	113	116	120	123	126	130	135	137	140	145	149	153	....	....	....		....	....	....	....	155	

Dominant. Codominant. Oppressed.

FORM NO. 5.

SITE: *f*. AGE CLASS: 240 to 260 years. SPECIES: White Pine.

Location.	Description of site.	Tree number.	Age.	Diameter (breast high).	Height.	Height to base of crown.	Rings per inch on stump.	Volume. Tree.	Volume. Merchantable timber.	Factor of shape.	Ratio of length of crown to total height of tree.	Lumber product under present practice; per cent used of total volume of stem.	Remarks.
			Yrs	*In.*	*Ft.*		*No.*	*Cu. ft.*	*Feet B. M.*				
Dubois, Clearfield County, Pa; latitude, 41° 3′; longitude, 78° 45′; altitude, 1,200 to 1,400 feet.	Hemlock, mixed with White Pine, with scattering Maple, Beech, and Birch, on a hill sloping toward southwest, where it is bordered by the left-hand branch of Narrow Creek. The moderately dense undergrowth consists of very young Beech, Hemlock and occasional Birch and Cucumber.	1	260	35½	158	90	7.6	435.4	3,030	0.40	0.43	58	Dominant.
		2	260	36	157	90	7.0	481.3	3,401	.43	.42	59	
		3	259	32	152	84	7.8	396.0	2,637	.46	.44	55	
		4	241	32	150	62	6.6	347.7	2,079	.41	.59	50	
		10	244	33	146	96	6.8	365.9	2,384	.42	.34	54	
		12	262	28	156	88	9.0	285.8	1,648	.43	.43	47	
		18	265	39	153	88	6.0	511.1	3,318	.40	.42	54	
		19	250	31	150	78	6.3	40[illegible].4	2,397	.42	.48	49	
		20	266	44	144	100	5.7	638.4	4,388	.42	.30	57	
		21	245	34	146	92	7.1	366.7	2,248	.40	.37	51	
		23	248	34	142	90	7.2	373.4	2,318	.42	.37	51	
		33	259	33	133	91	8.0	304.5	1,770	.40	.31	48	
		34	262	33	144	90	7.4	369.2	2,220	.42	.38	50	
		35	263	31	144	82	8.5	275.2	1,458	.36	.43	44	
		36	241	31½	134	88	7.1	307.7	1,853	.42	.34	50	
		37	261	37	146	106	6.7	482.9	2,970	.44	.27	59	
	Average	..	255	34	147	88	7.0	390.0	2,507	.41	.39	52	
	Soil: Yellow clay loam of a medium grain (fine shales in it), deep, fresh, well drained, with 2 to 3 inches mold on top, and with a surface cover of scanty leaves, fern, teaberries, and scattering Dogwood (Laurel in northeast corner and on north side). Subsoil: Laminated shale of an indefinite depth.	28	262	28½	138	75	9.8	261.3	1,551	.43	.45	49	Codominant.
		25	244	28½	138	107	7.7	298.1	1,954	.49	.22	54	
		24	245	25	130	84	9.3	192.1	1,102	.43	.35	18	
		22	246	31	130	82	7.3	310.3	1,731	.45	.37	46	
		5	264	29	140	100	8.4	300.4	1,905	.47	.28	52	
		6	264	29	140	110	8.5	294.4	1,631	.45	.24	47	
		7	262	29	152	112	9.5	302.8	1,854	.46	.26	51	
		8	235	29	142	86	....	218.6	1,318	0.38	0.39	44	
		9	236	32	142	84	....	287.7	1,648	.36	.41	48	
		11	244	30	141	81	7.5	305.3	1,947	.44	.42	53	
		13	258	24	141	93	9.6	206.0	1,048	.48	.37	12	
		14	242	25	139	98	....	217.1	1,233	.46	.30	47	
		15	262	26	136	98	....	257.2	1,389	.51	.28	45	
		16	235	24½	124	93	....	163.8	815	.40	.25	41	
		17	262	25	128	108	....	214.4	1,183	.49	.16	46	
		26	245	26	136	98	9 3	199 2	1,021	.40	.28	17	
		30	259	26½	134	90	9.2	228.6	1,336	.41	.32	18	
		29	264	28	141	81	9 2	276.5	1,577	.46	.40	47	
		31	262	25½	132	88	10.0	191.8	863	.41	.33	37	
		32	261	26	142	99	9 1	239.9	1,322	.46	.30	46	
	Average	...	253	27	138	93	9.0	250.0	1,121	.44	.32	47	
		27	259	19	132	94	11.6	138.8	683	.53	.29	41	Oppressed.
		38	260	23	137	96	11.1	189.6	987	.48	.30	43	
		39	258	20½	123	109	13 0	130.9	558	.46	.11	35	
		40	261	16½	120	82	13.7	89.6	339	.50	.31	31	
	Average	..	259	20	128	95	12.3	137.0	642	.49	.25	37	

FORM NO. 6.

SITE: *f*. LOCATION: Clearfield County, Pa. SPECIES: White Pine. DOMINANT GROWTH: Sixteen trees.

Age.	Diameter at height of 2½ feet (without bark).	Total height of tree.	Volume of stem (without bark).	Relative per cent of total volume.			Periodical accretion.																										Volume.	Average annual accretion.	Current periodic accretion.
							Decade.	Height.	Diameter and corresponding area.																												
									Cross section 1, at height of 2½ feet.		Cross section 2, at height of 18 feet.		Cross section 3, at height of 34 feet.		Cross section 4, at height of 50 feet.		Cross section 5, at height of 66 feet.		Cross section 6, at height of 82 feet.		Cross section 7, at height of 99 feet.		Cross section 8, at height of 114 feet.		Cross section 9, at height of 129 feet.									
				Heartwood.	Sapwood.	Bark.			Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.								
Yrs.	*In.*	*Feet.*	*Cubic feet.*	*Per ct.*	*Per ct.*	*Per ct.*		*Ft.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*In.*	*Sq. feet.*	*Cubic feet.*	*Cubic feet.*	*Cu. feet.*				
10	1.2	8	(*f*)	....	....	....	First	8	2.3	0.03	3.4	0.06	3.1	0.05	3.2	0.05	2.7	0.04	2.4	0.03	1.7	0.01	1.4	0.01	1.1	0.01	(*f*)	(*f*)	(*f*)				
20	3.4	23	0.8	....	....	....	Second	15	2.8	.12	2.9	.16	3.4	.18	2.9	.15	2.4	.10	2.2	.08	1.7	.05	1.5	.03	1.2	.02	(*f*)	0.04	(*f*)				
30	6.1	38	3.6	....	....	....	Third	15	2.3	.16	2.0	.15	2.0	.16	2.1	.17	2.3	.16	1.7	.11	1.6	.08	1.3	.06	1.1	.03	2.8	.12	0.28				
40	8.2	51	9.0	....	....	....	Fourth	13	2.1	.19	1.6	.16	1.7	.18	1.6	.15	1.6	.14	1.5	.11	1.3	.08	1.2	.06	1.1	.05	5.4	.22	.54				
50	10.2	64	17.0	....	....	....	Fifth	13	1.9	.22	1.6	.19	1.4	.16	1.2	.14	1.2	.13	1.3	.12	1.4	.10	1.1	.07	1.1	.06	8.0	.34	.80				
60	12.2	73½	27.0	....	....	....	Sixth	9½	1.9	.25	1.2	.16	1.2	.16	1.1	.14	1.2	.14	1.2	.13	1.2	.11	1.0	.08	.9	.06	10.0	.45	1.00				
70	14.2	82	40.0	....	....	....	Seventh	8½	2.1	.33	1.2	.17	1.0	.15	1.1	.15	1.2	.15	1.1	.13	1.0	.10	1.1	.09	.9	.07	13.0	.57	1.30				
80	16.1	90	52.0	....	....	....	Eighth	8	1.8	.32	1.0	.16	1.1	.17	1.2	.18	1.1	.16	1.1	.14	1.1	.13	.9	.09	.9	.08	12.0	.65	1.20				

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